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

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ABSTRACT

In Côte d'Ivoire and Ghana, many small-scale cocoa producers cultivate cocoa in unshaded or low-shaded plots, leading to challenges such as reduced biodiversity, soil fertility depletion, and increased soil erosion. To assess the adoption of sustainable agricultural practices in the cocoa sector, we develop a scale that incorporates dimensions of agroforestry, soil conservation, pest and disease management and farm sanitation. Using data from >1700 cocoa producers, we examine farmer participation in cooperatives and three main certification schemes (incl. Fairtrade, Rainforest Alliance and Organic) to understand their roles in promoting sustainable practices. We apply a multinomial endogenous switching regression model to control for potential selection bias and estimate the impact of participating in certification schemes, farmer cooperatives or both. In Côte d'Ivoire, econometric results show that joint participation in both a certification scheme and a farmer cooperative is associated with a significantly higher sustainability score. In Ghana, certification scheme membership shows the highest effect.

1. Introduction

The expansion of agricultural cash crop commodities poses a significant threat to biodiversity and ecosystem preservation (Hagger et al., 2017). Notably, the cocoa sector has received particular attention in recent years due to persistent issues such as farmer poverty, child labour and high levels of deforestation. Demand for cocoa is anticipated to increase, especially with the rising consumption of chocolate in emerging economies like India, China and Brazil (Jagoret et al., 2014). This is likely to drive the expansion of cocoa-producing areas, exacerbating such concerns. A notable trend among small-scale farmers is the preference for unshaded or low-shaded cocoa cultivation (Ruf, 2011), often involving the conversion of primary forest land into full sun cocoa plantations. This has both negative environmental and economic implications, as full-sun plantations rely on expensive inputs and hybrid cocoa varieties which require replanting every 15–20 years (Gockowski et al., 2013). Despite its drawbacks, this cultivation model, established in the 1960s, has persisted due to farmers' expectations of higher yields and rapid returns on investment (Asare et al., 2016). Agroforestry practices, including intercropping shade trees, have declined over time, discouraged by factors such as 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, various studies have outlined the environmental and ecological benefits of agroforestry systems, promoting 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).

The existing literature on the cocoa value chain predominantly focuses on its economic significance for farmers, evaluating aspects such as prices, income and productivity and its potential contribution to poverty reduction and food security (van Vliet et al., 2021; Waarts et al., 2021; Kongor et al., 2018). A limited number of studies have assessed the impact of cocoa agroforestry systems and individual agroecological practices, such as intercropping, on farmers' yields and incomes (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

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ecosystem functions, the relationship between biodiversity and profitability is either unclear in Cameroon (Bisseleua et al., 2009) or involves a trade-off between biodiversity and yields in Indonesia (Steffan-Dewenter et al., 2007).

Against this background, the significance of public standard setting and private certification schemes in the agricultural sector, including cocoa, has markedly increased in recent years. Many of the standards are designed to limit environmental degradation by promoting and mandating the use of sustainable production practices. Approximately 30% of the global cocoa production is estimated to be certified, with a concentration in Côte d'Ivoire (Willer et al., 2019; Uribe-Leitz and Ruf, 2019). Several studies have specifically examined the role of private sustainability schemes, such as Fairtrade or Rainforest Alliance, in improving various aspects of cocoa farming, including 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).

There is a notable gap in research that specifically addresses the agronomic outcomes of certification schemes within the cocoa sector. We therefore look beyond the sector and broaden our review. Among the literature on perennial crops, research in the coffee sector has received considerable attention but produced mixed results regarding the effects of sustainability standards and certification. For instance, studies have concluded that (eco)-certification leads to more environmental-friendly practices in coffee production. In Costa Rica, Blackman and Naranjo (2012) observed lower chemical input usage, while in Colombia, Rueda and Lambin (2013) and Ibanez and Blackman (2016) reported improved environmental management. Furthermore, studies conducted in Uganda, Nicaragua, and Brazil found evidence of higher biodiversity and increased carbon storage associated with (eco)-certification (Vanderhaegen et al., 2018; Hagger et al., 2017; Hardt et al., 2015). However, not all studies find positive effects. Elder et al. (2013) concluded that Fairtrade certification did not have a significant impact on farming practices of coffee farmers in Rwanda. A comprehensive review by DeFries et al. (2017), encompassing 20 studies on coffee certification that rigorously analysed differences between treatment and control groups, found inconsistent results across environmental, economic and social benefits. Limited effects of certification on the adoption of sustainable agricultural practices (SAP) in small-scale farms have been attributed to a scale mismatch between farms and the necessity for biodiversity maintenance at larger landscape level (Tscharnke et al., 2015; Holzschuh et al., 2007).

Certifying bodies and institutions supporting farmers often aim to leverage existing organizational structures at the producer level. In this context, farmer cooperatives are play a central role in rural development, serving as key players in marketing agricultural output, facilitating capacity development and providing access to services such as inputs or loans (Francesconi and Wouterse, 2015). Therefore, consistent efforts have been undertaken to promote the establishment of farmer cooperatives in the cocoa sector. Estimates regarding the prevalence of of cooperative membership in the main cocoa growing countries vary significantly, ranging from approximately 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 highlighting the benefits of small-scale farmer organization (Mojo et al., 2017; Fischer and Qaim, 2012; Markelova et al., 2009), limited attention has been directed wards the cocoa sector especially in Ghana and Côte d'Ivoire. One reason for this may be the perceived lack of autonomy of farmer cooperatives, particularly in Côte d'Ivoire, where cooperatives appear to function more as a mechanism to "organise the countryside" (Woods, 1999). The set-up of cooperatives seems to be more of a process under government control rather than a movement of collective action (Uribe-Leitz and Ruf, 2019). In addition to the government, development programs, non-governmental organizations and companies themselves have set up farmer-based organizations and cooperatives (Francesconi and Wouterse, 2015).

Regarding the functioning of cooperatives, studies highlight issues such as poor management, lack of financial resources and inability to effectively support farmers (Löhr et al., 2021; Bymolt et al., 2018). An exception is a study by Calkins and Ngo (2010), which identifies cooperative membership as having a positive income and well-being effect. However, it is noteworthy that this study employs a one-way ANOVA and *t*-tests to detect significant difference across the different groups, rather than using regression analysis that can address selection bias. Consequently the conclusions to be drawn from the study is limited. Similarly, other studies focus on providing descriptive information regarding farmers' access to inputs, training and information facilitated by cooperatives (Bymolt et al., 2018; Ingram et al., 2017).

Very few studies rigorously address the identification of agricultural practices in cocoa production that effectively balance ecological and economic considerations. At the same time, there is little understanding of how farmers can be adequately supported and encouraged in adopting more sustainable practices. In this paper, we therefore aim to bridge this gap by evaluating the role that organizational structures and market channels can play in providing this support to farmers.

We consider two major impact pathways that can facilitate the adoption of more sustainable farming practices, namely certification schemes and farmer cooperatives. First, our analysis focusses on the three most important certification schemes in cocoa production - Rainforest Alliance, Fairtrade and Organic. These schemes have clear sustainability objectives, reflected in mandatory standards that certified producers have to adhere to. These requirements encompass a range of measures, including soil conversation practices, integrated pest management and adequate input use. Ensuring compliance with these requirements primarily involves providing various training modalities, such as in-classroom sessions, farmer field schools, and demonstration plots. Additional support is often provided through improved access to credit and/or agro-inputs (Boonaert and Maertens, 2023).

Second, we consider farmer cooperatives as organizational structures within smallholder agriculture, a sector often perceived as inefficient and the lacking economy of scale necessary to take full advantage of its natural endowments. Nevertheless, the vast majority of cocoa producers operate on a small scale. Given the nature of various stages in perennial crop production, such as planting, pruning, and harvesting, mechanization proves challenging. With only two primary harvesting periods annually, family labour, rather than hired labour, is typically sufficient for routine farm maintenance. However, small farmers, particularly when living remote, can face constraints in accessing input and sales markets. Cooperatives can play an important role in providing farmers with a shared space for capacity development, joint acquisition of inputs and bargaining power for better market conditions and prices (Bymolt et al., 2018). Notably, we account for the interrelatedness of certification schemes and farmer cooperatives, recognizing that standards and cooperatives can mutually support each other despite having different objectives (Develtere and Pollet, 2005).

For our analysis, we use a survey data set that was collected by the Joint Research Centre of the European Commission and the Centre Ivoirien de Recherche Économique et Sociale (CIRES). Covering all cocoa growing regions across both Côte d'Ivoire and Ghana, the data set is nationally representative. We evaluate the effect of participation in (1) a certification scheme, (2) a farmer cooperative or (3) both and compare these groups to the control group of non-participants.

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 globally in terms of scale of production. In 2019, together they accounted for approximately 61% of the world's cocoa production (ICCO, 2020). In 2019/ 2020 (the year of data collection for this study), Côte d'Ivoire produced nearly 2.1

million metric tons, while Ghana produced 770 thousand metric tons of the overall 4.7 mil metric tons produced world-wide (ICCO, 2020). The cocoa industry contributes substantially to both countries' government revenues and rural economies. In Ghana, for example, cocoa employs around 60% of the national labor force in agriculture (Ntiamoah and Afrane, 2008).

Irrespective of the production system or cultivated varieties, both Côte d'Ivoire and Ghana show relatively low cocoa yields in contrast to other cocoa-producing countries. Research findings indicate that average yields in Côte d'Ivoire range between 300 and 500 kg/ha (Ingram et al., 2017; Bymolt et al., 2018), and between 400 and 500 kg/ha in Ghana (Bymolt et al., 2018; Kongor et al., 2018). Nevertheless, Abdulai et al. (2020) estimate that, under optimal conditions, Ghana could achieve yields exceeding 2000 kg/ha. The low yields are often attributed to factors such as the old age of cocoa trees and the high prevalence of pests and diseases in West African cocoa production. These include insect pests such as mirids, capsids, or stemborers, weed pests like mistletoe, fungi such as black pod disease, as well as virus infections like swollen shoot disease. Black pod disease has been estimated to cause losses ranging from 30 to 50% in Ghana (Opoku et al., 2000). Poor farm management practices often exacerbate the challenges that farmers already face.

Cocoa production in Côte d'Ivoire and Ghana is predominantly characterized by unshaded or low-shaded cocoa production. Attitudes towards 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 thrive better in full sun conditions rather than shaded systems (Ruf, 2011).

2.2. Sampling and data collection

A nationally representative survey of cocoa producers was conducted by the Joint Research Centre of the European Commission and the Centre Ivoirien de Recherche Économique et Sociale (CIRES) in Côte d'Ivoire and Ghana, applying 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 10^{o} North and 10^{o} South of the equator where climatic conditions are most favourable for cocoa cultivation. Second, villages were then randomly selected from existing population census data. A comprehensive list of all cocoa farmers was compiled in the selected villages and enumeration areas, from which cocoa farmers were then randomly selected for interviews.

Data collection took place between August 2019 and January 2020, which mostly coincided with the primary harvesting season. The structured questionnaire was predominantly administered to the self-identified head of the household, covering topics such as 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 well-trained team of local field assistants proficient in interview techniques.

The data set includes 1.745 cocoa producing households from a total of 146 villages, with 1.219 households interviewed in Côte d'Ivoire and 527 in Ghana.

2.3. Measuring sustainability in cocoa production

Our objective is to identify the extent to which farmers in Côte d'Ivoire and Ghana apply sustainable farm management practices in cocoa production, given the prevalent environmental concerns related to chemical input application, pesticide use and biodiversity loss (Ntiamoah and Afrane, 2008). While sustainable agricultural practices commonly involve limiting the use of pesticides, herbicides and chemical fertilizer (Kleemann and Abdulai, 2013), we believe that observed practices may result from farmers' resource constraints, limited market access, or knowledge gaps rather than a deliberate environmental preference. We therefore focus on the application of practices that denote an intentional decision rather than a default choice, and we develop a Sustainable Agricultural Practices (SAP) scale accordingly.

Given the absence of a consensus in the literature regarding what qualifies as SAP in cocoa, we construct a scale that considers multiple dimensions contributing to farm-level sustainability. We define SAP as practices that maintain simultaneously support biodiversity preservation through maintaining a diverse ecosystem (e.g., tree diversification on cocoa plots) and optimize yields by managing diseases and pests. This means that through the application of SAP, farmers can create a dynamic and ecologically based production system that can both contribute to increased yields and therefore provide social, economic as well as environmental benefits (Asare and David, 2011).

We select SAP indicators based on information derived from peer-reviewed journal articles and knowledge from practitioners and producers, reflected in farming manuals such as the “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) serves as a valuable conceptual model for sustainable practices in developing countries (Schader et al., 2014). Some of the indicators formulated should be considered as minimum requirements rather than the optimal level of sustainable practices. For example, Waldron et al. (2015) estimate 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”, advocating for 15 shade trees per hectare, as we consider this to be more practical in the current context of cocoa production.

We additionally take into account the cost effectiveness of approaches, recognizing that substantial investments are often not feasible for small cocoa farmers. As outlined in Section 2, we exclude low input use of chemical inputs such as pesticides, herbicides and fertilizer as indicators for sustainable practices. The rationale behind this exclusion is that low input use may be attributable to financial constraints or limited market access rather than deliberate environmental considerations.

Table 1 presents an overview of the ten individual indicators selected, organized into four dimensions that we recognize as SAP in cocoa production. Each of these four dimensions - 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 standardize the data to a scale between 0 and 1 for easier interpretation. Our sustainability scale is not without limitations. Our outcome variables rely on survey-based data, reliant on information provided at one point in time and by farmers themselves. They may have an interest in portraying their farming practices more sustainable than they actually are. Future research should therefore explore more objective methodologies to measure the extent of the application sustainable agricultural practices. Utilizing time series data would allow for a more long-term analysis to assess the longevity and maintenance of practices over time.

3. Estimation strategy

We identify two impact pathways associated with organizational structures and market channels, anticipating a positive effect on the adoption of SAP: 1) farmer participation in certification schemes and 2) membership in farmer cooperatives. Table 2 presents an overview of the various participation strategies of farmers in organizational structures and market channels within our sample. In Côte d'Ivoire, approximately 13% of cocoa farmers report to being a member of a cooperative in comparison to about 20% of farmers in Ghana. Furthermore, around 16% and 25% of cocoa producers grow certified cocoa in Côte d'Ivoire and Ghana, respectively. The literature offers limited verified information about the extent of farmer membership in cooperative, with estimates ranging from 21% in Côte d'Ivoire to 11% in Ghana (Bymolt et al.,

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 the mitigation of soil erosion. Different shade levels can protect cocoa crops from weeds, parasitic plants and certain pests and diseases while also providing 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	Species diversification is beneficial to biodiversity. Tree diversity can help manage different pests and diseases, acting as barriers to prevent the spread of infections among 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.) is preferable to the (over-) use of chemical fertilizer, as it is less harmful to soil biodiversity.
Manual weeding	Whether or not the household manually weeds the cocoa plot(s)	Manual is favoured over chemical weeding to sustain a rich farm biodiversity. Chemical weeding often kills more than weeds and contributes to groundwater pollution.
Intercropping	Whether or not the household produces >1 food or cash crop on at least 1 of their plot(s)	Intercropping, as a practice of increasing crop diversity, 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	Pruning enables optimal air circulation, enhancing wind-pollination, and therefore contributing to improved pod setting. Reduces the incidence of pests and diseases.
Insect population count	Whether or not the household has implemented an insect population count in last 12 months	Conducting insect population count assesses the medium- to long-term insect risk. This allows for planning of appropriate measures, avoiding indiscriminate insecticide application without a thorough knowledge of the insect population.
Observation of insects before treatment	Whether or not the household has established the presence of insects (through observation) before performing a treatment	The observation of insects before treatment allows for the development of targeted short-term treatment based on the immediate presence of insects.
Cocoa tree and farm sanitation		
Sanitary harvest	Whether or not the household performs sanitary harvesting	Cutting black, rotten or diseased pods and destroying them avoids the spreading of diseases. Manual removal rather fungicide or herbicides application 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 mitigates the risk of further land expansion as dead or aged trees are replaced.

2018). Given the more formalized nature of certification schemes, information is more available, albeit with some inconsistencies across sources. Potts et al. (2014) estimate that approximately 29.3% of Ivorian and 15.9% Ghanaian cocoa farmers are certified, predominantly under Rainforest Alliance.[1] In comparison, Bymolt et al. (2018) report that only 7% of farmers in Côte d'Ivoire to and 24% in Ghana confirm their certification status.

To verify that a farmer's certification status, we rely on the following information: (1) whether the farmer reports selling certified cocoa or is uncertain about it and (2) whether the farmer has participated in a training. Certification schemes, such as Rainforest Alliance, often require farmers to participate in at least one training on good agricultural practices to qualify for certification. The main certification schemes considered are Rainforest Alliance, Fairtrade and Organic certification, with an “Other” category encompassing schemes that farmers cannot name. This category may include sustainability projects by exporter companies, such as Cocoa Horizons (Barry Callebaut), Cocoa Compass (by Olam) or Cocoa Promise (by Cargill). These type of projects impose similar farm management and cocoa production requirements, offering trainings on good agricultural practices, and improving input accessibility. Regarding cooperative membership, we include farmers that confirm membership in a registered cooperative, to which they sell their cocoa. Although other entities, such as farmer groups or producer associations, may support farmers, we believe the most significant effects will result from legally established cooperatives with defined rights and obligations for their members. Nonetheless, this approach may imply that our findings underestimate the impact of cooperatives regarding the sustainable practices as farmers receiving support through informal groups would be included in the control group. As presented 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. Further, there may be reverse causality between the farmer's participation in organizational structures and market channels and the adoption of sustainable agricultural practices. This selection bias occurs when unobservable factors influence the error terms of both the selection and outcome equations, resulting in the correlation in the error terms (Kleemann and Abdulai, 2013). Not accounting for selection bias could lead to biased results and potentially overestimate the effects of farmer participation in organizational structure and market channels. To model the interrelatedness of participation options and address potential selection bias, we apply a multinomial endogenous switching model - a variant of the instrumental variable approach (Midingoyi et al., 2019). This model consists of two stages, namely the selection regression and the outcome regression. First, the farmer's 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

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

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%)

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).

3.1. Multinomial selection regression

Farming households are assumed to aim for utility maximisation given constraints such as resources or information availability. Therefore, participation in certification schemes and farmer cooperatives becomes attractive only if 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 expressed as follows:

$$U_{ij} = X_i\alpha_j + \varepsilon_{ij} \tag{1}$$

where maximum utility U is derived by farmer i through choosing option j, where $j = 0, 1 \dots M$ (M representing 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 underlying 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 directly observe the utility of a choice, we observe cocoa farmers' decision regarding their participation in organizational structures and market channels:

$$D_i = \left\{ \begin{array}{c} 1 \ if \ D_{i1} > max_{k \neq 1} D_{ik} \\ \vdots \vdots \vdots \\ M \ if \ D_{iM} > max_{k \neq M} D_{ik} \end{array} \right\} \tag{2}$$

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 of farmer i chosing option j can be specified as follows:

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

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,

$$\left\{ \begin{array}{c} Regime\ 1 : y_{i1} = Z_i\beta_1 + \mu_{i1} \ if \ D = 1 \\ \vdots \vdots \vdots \\ Regime\ M : y_{im} = Z_i\beta_m + \mu_{im} \ if \ D = M \end{array} \right. \tag{4}$$

where y_{im} is the SAP scale of the ith farmer in regime m. Here, regime 1 corresponds to participation in a certification scheme, regime 2 to participation in a farmer cooperative, and regime 3 to 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 Eq. (4) captures the impact of the participation in different regimes on the utilization 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). Using the same explanatory variables in the selection and outcome equations may hinder the identification of different outcome equations and lead to multicollinearity issues (Midingoyi et al., 2019). Consequently, 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 nearest buyer of certified cocoa and the closest farmer cooperative as our exclusion restrictions. Distance measures are commonly used as instruments, especially 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:

$$\left\{ \begin{array}{c} Regime\ 1 : y_{i1} = Z_i\beta_1 + \sigma_1\lambda_{i1} + \omega_{i1} \ if \ D = 1 \\ \vdots \vdots \vdots \\ Regime\ M : y_{im} = Z_i\beta_m + \sigma_m\lambda_{im} + \omega_{im} \ if \ D = M \end{array} \right. \tag{5}$$

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 is the potential bias in the standard errors (Ding and Abdulai, 2020). To address this, the standard errors in Eq. (5) are 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 individual participation options in organizational structures and market channels (Kumar et al., 2019). The expected outcome values of farmers who choose to participate in farmer cooperatives, certification schemes or both (as observed in the sample), are computed as follows:

$$\left\{ \begin{array}{l} E(Y_{i1}|\,D_i = 1) = Z_i\beta_1 + \sigma_1\lambda_1 \\ E(Y_{i2}|\,D_i = 2) = Z_i\beta_2 + \sigma_2\lambda_2 \\ E(Y_{i3}|\,D_i = 3) = Z_i\beta_3 + \sigma_3\lambda_3 \end{array} \right. \tag{6}$$

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

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

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:

$$\{E(Y_{i0}|\, D_i = 0) = Z_i\beta_0 + \sigma_0\lambda_0 \quad (8)$$

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

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

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

4. Results and discussion

4.1. Descriptive statistics

Table 3 presents descriptive statistics for the variables used in the regression analysis as control and instrumental variables. The statistics are provided separately for Côte d'Ivoire and Ghana, offering a comparison across the different treatment groups (only certified, only member of a farmer cooperative and both) to non-participants. The full sample for each country is also included.

We note that cocoa farmers in Côte d'Ivoire and Ghana differ from each other in several characteristics. In terms of formal education, cocoa farmers in Côte d'Ivoire have received 3–4 years of schooling, whereas farmers in Ghana have attended school for 7–8 years. Particularly cooperative members in Côte d'Ivoire have attended school the longest, while in Ghana, no significant differences are observed among the subgroups. Despite female household heads in Ghana being more actively involved in cocoa production compared to those in Côte d'Ivoire, they are notably less likely to be certified or engaged in cooperatives.

Ivorian farmers are more likely to have migrated, either from other regions within Côte d'Ivoire or from neighbouring countries, to the farm they currently own, lease or cultivate on behalf of others. In Ghana, migrants are more involved in organizational structures or market

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	Certified member of a farmer cooperative	Neither certified nor member of a cooperative	Full sample Ghana	Only Certified	Only Member in farmer cooperative	Certified member of 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)
Migrant[a]	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 ratio[b]	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	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)
Km to plot	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 terrain[c]	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	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 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 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	1219	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.
[a] Household Head was not born in the region where (s)he currently lives and farms.
[b] Household ratio of working age adults to dependents (children or elderly).
[c] Majority of cocoa plot(s) of household are flat plots either on hilltops or plateaus.

channels, possibly indicating a stronger inclination to integrate into supportive systems and networks. Conditions that facilitate farmers' access to information and markets, such as good road networks or mobile phone coverage, is relatively comparable across the two countries. However, while 85% of Ghanaian farmers have access to electricity, only about 50% of farmers in Côte d'Ivoire do. 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, between Côte d'Ivoire and Ghana. Diseases are widespread in both countries, with over half of the farmers reporting severe black pod disease, a fungus, affecting their cocoa production. Swollen shoot virus, which requires the complete removal of the infected tree, is somewhat more prevalent in Côte d'Ivoire than in Ghana. With slightly >3.6 ha, average cocoa farm sizes are similar in both countries. This contrasts some literature that generally reports larger cocoa farms in Côte d'Ivoire, ranging between 4.17 and 4.31 ha (Bymolt et al., 2018). However, it is important to note that studies often do not differentiate between the total farm size of cocoa farmers and the size of their cocoa plots only. In this study, we consider the sum of cocoa plots. Among farmers grouped into different subgroups, particularly those with larger farms and richer soils, engage in organizational structures and market channels.

In addition to household and farm characteristics, we present the Sustainable Agricultural Practices (SAP) scale and its individual indicators in Table 4. The data indicates variations in agroforestry practices, like the prevalence of shade trees, which is more common in Ghana than in Côte d'Ivoire. However, farmers in both countries favour full-sun or low-shade cocoa production, consistent with existing literature (Uribe-Leitz and Ruf, 2019). Notably, around 9% of Ghanaian farmers, which increases to 34% among those both certified and a member of a cooperative, report to grow at least 15 shade trees per hectare on their cocoa plots. In comparison, only about 6% of farmers in Côte d'Ivoire have a minimum of 15 shade trees on their plots. Additionally, the majority of certified farmers in both countries integrate least two tree species, beyond cocoa, into their cocoa plots.

Several practices are widely adopted in cocoa production, including pruning, manual weeding, and sanitary harvesting. Most farmers state having pruned their cocoa trees within the past three years, contrasting with earlier research. Foundjem-Tita et al. (2017) collected data in 2014/2015, which reveals that only about 17% of Côte d'Ivoire farmers pruned their farms in the previous five years. This discrepancy could be attributed to increased efforts within the cocoa sector to promote tree pruning. In Côte d'Ivoire, particularly certified farmers and members of a cooperative prefer manual weeding over chemical methods.

Other practices are much less widespread. Fewer farmers, around 3% on average in both Côte d'Ivoire and Ghana, utilize organic fertilizer, possibly due to limited knowledge or challenges accessing inputs like manure. Integrative pest management practices such as regular insect counts are also uncommon. Interestingly, certified farmers in Côte d'Ivoire observe insects before treatment opting for a more targeted pest control approach. On the contrary, certified farmers in Ghana are least likely to do so across all comparison groups. Progressive replantation, involving the continuous replacement of diseased or aged cocoa trees to prevent the replacement of entire plots or expansion into forested areas, is practiced by farmers that are both certified and members of farmer cooperatives to rejuvenate their farms.

Overall, the score on the SAP scale is not necessarily higher for

Table 4
Descriptive statistics of sustainable agricultural practices.

	Côte d'Ivoire					Ghana				
	Full sample Côte d'Ivoire	Only certified	Only member in farmer cooperative	Certified member of a farmer cooperative	Neither certified nor member of a cooperative	Full sample Ghana	Only certified	Only member in farmer cooperative	Certified member of 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	1219	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.

farmers engaged in marketing or organizational structures. In Côte d'Ivoire, certified farmers show a modestly elevated SAP scale score of 0.08, while those with both certification and cooperative membership score an increase of 0.12 compared to 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.

4.2. Determinants of participation in certification schemes and farmer cooperatives

Table 5 presents the parameter estimates derived from the probit selection equation from the first stage of the multinomial endogenous switching regression model. The binary dependent variable reflects the decision-making of cocoa farmers signifying whether they opt to 1) participate in a certification schemes, 2) become a member of a farmer cooperatives or 3) both. This decision is intricately influenced by household and farm plot characteristics as well as the accessibility of services fostering 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 limited access to information or networks disseminating knowledge about such structures. The time-intensive nature of engagement, such as meetings for collective decision-making or training sessions, could impede the involvement of women farmers. 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 underscore the influence of farm characteristics, such as plot distance and the soil quality, on farmers' involvement in organizational structures or market channels. Greater distances to plots decrease the likelihood of cocoa farmers in Ghana engaging in farmer cooperatives, possibly due to time constraints associated with travel requirements.

Our instrumental variables are in line with our expectations and the existing literature. They show a negative correlation between distance and membership in certification schemes and farmer cooperatives. The results are much more indicative in Côte d'Ivoire than in Ghana, suggesting that Ghanaian farmers, being more resource-endowed, can potentially overcome distance through vehicle ownership or access to public transport.

4.3. Impact of farmer's participation in certification schemes and farmer cooperatives on sustainable agricultural practices (SAP)

Table 6 shows the Average Treatment Effects on the Treated (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. For every participation option, the ATT compares the outcomes for adopters with adoption (actual) with adopters had they decided not to adopt (counterfactual). We also calculate the effects of non-participation in the three options, known as the Average Treatment Effect of the Untreated (ATU). The ATU is the outcome of non-adopters without adoption (actual) in comparison to non-adopters had they decided to adopt (counterfactual). The SAP scale, ranging from 0 to 1 (with 1 being the highest achievable score), measures the intensity of sustainable agricultural practices. 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 – each weighted equally with 0.25.

In Côte d'Ivoire, the findings indicate that farmers' involvement in organizational structures and market channels indeed leads to a higher score on the sustainability scale. The highest treatment effect, with an ATT of 0.243, is observed through joint participation in a certification scheme and a farmer cooperative. This aligns with expectations, as it is hypothesized that organizational structures like farmer cooperatives can serve as a support system for implementing the standards promoted and required by certification schemes.

We further observe a larger Average Treatment Effect on the Treated (ATT) for cooperative membership compared to certification. Since 2010, Côte d'Ivoire has intensified its efforts to professionalize

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		Certified member of a farmer cooperative		Only certified		Only member in farmer cooperative		Certified member of 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
Dependency ratio	0.155	0.108	−0.163	0.133	0.022	0.103	0.763**	0.319	0.507	0.415	1.532***	0.510
Mobile phone	−0.186	0.214	0.632**	0.301	−0.252	0.293	−0.539	0.425	−0.866**	0.381	0.069	0.456
Home accessible by vehicle	0.375	0.343	0.310	0.308	−0.274	0.284	−0.458	0.528	−0.075	0.324	0.622	0.471
Electricity	0.103	0.190	−0.067	0.170	0.204	0.254	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 *** ($p < 0.01$).

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	0.622	0.580	ATT = 0.118***
	No	0.505	0.455	ATU = 0.125***
Cooperative membership	Yes	0.589	0.557	ATT = 0.032
	No	0.449	0.455	ATU = −0.006
Cooperative membership and certification	Yes	0.640	0.555	ATT = 0.068***
	No	0.680	0.455	ATU = 0.225***

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

cooperatives in the country, primarily through the implementation of the Uniform Act on cooperative law. This effort to formalize co-operatives has led to a “conversion” of former cocoa buyers and traders into so-called cooperatives, which may not necessarily adhere to democratic processes and cooperative values of participatory action (Ruf et al., 2019). Nevertheless, this process has facilitated the operation of cooperatives, allowing them to provide training and support by committing the necessary resources (Foundjem-Tita et al., 2017).

Farmers who are not involved in organizational structures and market channels show lower scores on the SAP scale compared to those participating. The Average Treatment Effect of the Untreated (ATU) is also positive and significant, emphasizing 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 stand out, yielding 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 generally higher than those in Côte d'Ivoire, even for the control group. The ATT reinforces our presumed 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 most significant effect on farmers. Several factors could explain these findings. Ghana has a highly regulated cocoa sector with robust support structures, facilitated by the Ghana Cocoa Board. While the establishment of cooperatives has been encouraged through governmental and non-governmental initiatives in recent years, individual assessments indicate that cooperatives often 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 further indicate that certification plays a more substantial role than cooperative membership. The current functionality of farmer cooperatives may even negatively affect the adoption 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.

5. Discussion and conclusion

There have been increasing calls to enhance the economic, environmental and social sustainability of global value chains, including cocoa. This growing awareness is also as a response to increased media coverage on the challenges faced by producers in developing countries. The impacts of climate change and weather conditions exacerbate the difficulties experienced by agricultural producers. At the same time, full-sun or low-shade cocoa production systems dependent on high input use and cocoa hybrids requiring replanting every 15–20 years (Gockowski et al., 2013), are increasingly recognized as environmentally but also economically unsustainable.

Agroecological practices, such as agroforestry, intercropping and bio-based alternatives to chemical inputs, are currently promoted in Côte d'Ivoire and Ghana, the two largest cocoa producers world-wide. Despite these efforts, the literature suggests a slow adoption such practices, as farmers continue to favour the long-promoted low-shade system for its quicker return on investment (Asare et al., 2016). This study explores the potential impact of organizational structures and market channels, specifically certification schemes and farmer co-operatives, in encouraging farmers to transition to more sustainable agricultural practices (SAP). Using survey data from over 1700 small-scale cocoa farmers in Côte d'Ivoire and Ghana, we employ a multinomial endogenous switching regression to control for issues of endogeneity caused by self-selection and reverse causality problem and to account for the interrelatedness of different organizational structures and market channels.

Our methodology has limitations and the results should be considered with caution. We rely on cross-sectional data, derived from self-reported information provided by cocoa producers. While our econometric approach aims to mitigate potential endogeneity, complete elimination is challenging. 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 prevalent. Variations in local production practices and conditions should be recognized for sustainability characteristics of cocoa production to be relevant in specific contexts. Despite these considerations, we believe our findings contribute to understanding the role of local support structures in promoting sustainable agricultural practices.

In Côte d'Ivoire, the most pronounced treatment effect is observed when farmers take part simultaneously in certification schemes and farmer cooperatives. These findings are in line with our expectations, indicating that certification schemes benefit from the on-the-ground support and management provided by organizational structures, especially when there is a high level of trust and confidence of farmers towards the institution. In Ghana, certification demonstrates the largest treatment effect, with cooperative membership contributing slightly limited added value. This may be explained by the highly regulated cocoa sector in Ghana, where the Cocoa Health and Extension Division of the Ghana Cocoa Board offers services and support that farmers co-operatives might otherwise provide. Our econometric approach also allows us to estimate the hypothetical effects of participating in organizational structure and market channels for farmers not currently 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, this effect seems to be driven by certification, while in Côte d'Ivoire, cooperative membership appears to be the driving force.

When considering the components of the SAP scale, it becomes evident that certain agricultural practices, such as shade tree planting or organic fertilizer, may require more in-depth knowledge or financial resources than others. Furthermore, our findings indicate a relatively modest effect of certification schemes on the adoption of SAP. These schemes may not effectively tackle barriers to adoption, such as time constraints, limited resources, input accessibility, or legal security concerning land and shade trees. Local long-term structures can help farmers overcome these high barriers. However, it's essential to recognize that these structures are not a panacea. A common criticism in recent years is 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 associated with meeting sustainability standards (Uribe-Leitz and Ruf, 2019) may therefore result in minimal benefit, potentially discouraging the continuation of such schemes. Barriers of adoption, such as time and resource constraints, input access or legal security of land and shade trees, are possibly not sufficiently addressed by certification schemes to support farmers overcome their constraints.

With only a relatively small share of cocoa farmers currently participating in certification schemes and adhering to sustainability standards, the prospects for their expansion face challenges. If the farmers' share was to increase, the oversupply of certified cocoa beans could result in even fewer benefits for producers.

Moreover, farmer cooperatives often fall short of delivering the necessary support farmers require. Uribe-Leitz and Ruf (2019) and Woods (1999) highlight criticisms such as their dependence on external assistance, conflicting economic interests, elite capture and lack of inclusiveness. Ruf et al. (2019) emphasize that most cooperatives in Côte d'Ivoire do not apply the values of collective decision-making and democratic management, as many have been established by former cocoa buyers and traders. Additional challenges arise from from administrative practices that do not align with the realities of land ownership and on-the-ground farm management. Skalidou (2020) reports that in Ghana, farmers must present a so-called "farm passbook" to register with a farmer cooperative. Yet, these passbooks are usually held by farm owners rather than those managing the farm or leasing the land – leaving farm managers without access to training or extension services offered by cooperatives.

At the same time cooperatives may face constraints in improving market access or securing adequate prices for farmers within the highly regulated cocoa sectors in Ghana and Côte d'Ivoire. If cooperatives are unable to generate equal value for all members, farmers may not perceive the benefits of cooperative membership. Nonetheless, as our analysis indicates, they can serve as entry points for engaging with farmers and providing advisory services to promote more sustainable practices. Recognizing their roles within the "broader institutional environment" is crucial (Snider et al., 2016). Further research on farmer cooperatives, particularly focusing on the formalization of transparent roles, responsibilities and membership participation, would contribute to identifying characteristics that support their functionality, ownership and service provision.

The European Commission recently introduced a new regulation designed to limit deforestation, eliminate child labour and alleviate poverty associated with agricultural imports into the European Union. To successfully reshape the dynamics of value chains, such a proposal must take into account all levels within the chain, with a specific focus on the producer level. This requires a collaborative and inclusive effort, emphasizing the enhancement of existing local structures. The overarching goal is to create an environment that empowers farmers and foster sustainable practices cocoa production.

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CRediT authorship contribution statement

Katharina Krumbiegel: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Pascal Tillie:** Data curation, Project administration, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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