Journal of Integrative Agriculture 2021, 20(10): 2820–2836

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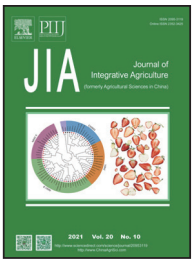

RESEARCH ARTICLE

Assessing the impact of non-governmental organization's extension programs on sustainable cocoa production and household income in Ghana

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Abstract

Globally, cocoa is famous for the production of chocolates and beverages. However, it also serves as a source of raw material for the manufacturing of high-quality cosmetic and pharmaceutical products. Due to its high demand, cocoa is regarded as a major commodity for poverty alleviation in deprived cocoa farming communities. Government has therefore instigated relevant measures to address issues facing the sector by investing in extension programs. These programs act as information dissemination tools for teaching modern farming technologies and enhancing learning among farmers. This study highlighted the effects of the Cocoa Life Project (CLP) by Cooperative for Assistance and Relief Everywhere (CARE) International on farm productivity and income of 200 cocoa farmers in three districts of the Eastern Region, Ghana. Regression on covariates, Heckman's treatment effects model, and propensity scores were used to test the robustness of the estimates. A positive association between extension program participation, farm productivity, and household income was discovered. Specifically, after correcting for selection bias, the estimated results of the Heckman's model showed that the extension program significantly increased participating farmers' cocoa yield by 14.3%. The effects on total farm income showed a significant increase of 25.1 and 42.9%, respectively from regression on propensity scores and the Heckman's model. Across all three models, program participation led to an increase in total household income by 46.1, 31.7, and 69.3%, respectively. Other variables such as farming characteristics, institutional and demographic factors affected farmers' income, depending on the estimation method used. This study reiterated the supporting role played by extension programs in enhancing cocoa production and increasing household income in Ghana. Conclusively, government and development partners should invest in extension programs by providing enough logistics, training qualified agents, and creating a conducive atmosphere to support learning and technology adoption.

Keywords: cocoa, extension, Heckman's model, regression on propensity scores, smallholders

Received 11 May, 2020 Accepted 3 January, 2021
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doi: 10.1016/S2095-3119(21)63607-9

1. Introduction

Currently, an important research area in Ghana is improving the welfare of smallholder farmers by developing and reforming policies in the agricultural sector (Okoffo

et al. 2016). This is necessary due to the benefits derived from sustainable agriculture in the form of constant food supply and generation of income both locally (trade within the country) and externally *via* exports (Mahrizal *et al.* 2014; Guliyev *et al.* 2019). Another benefit is the sector's ability to generate employment in many other subsectors and ultimately feed the industrial set-ups with the requisite raw materials (Addai *et al.* 2014). However, due to inherent issues such as lack of credit, failed government policies, and unpredictable climatic conditions, agricultural development has been seriously impeded and so have farmers' livelihoods that rely on agriculture (Peprah 2015). Among such are rural cocoa farmers in Ghana, producing almost a quarter of the world's total cocoa output and placing the country as the world's second-largest cocoa producer behind Ivory Coast (Gockowski *et al.* 2011).

The cocoa sector, which contributes nearly 10% to gross domestic product (Anang *et al.* 2011; Kongor *et al.* 2018) and supports nearly four million livelihoods (about 16.5% of Ghana's 24.5 million population), requires substantial investment and research into the sustainability and welfare of farmers to maintain their interest in the farming business. However, the sector is dominated by smallholders cultivating on land plots less than 2 ha, employing traditional production methods, and obtaining low yields (Danso-Abbeam *et al.* 2012). Dissemination of modern agricultural technologies to rural farmers will achieve successful agricultural productivity and growth and ultimately reduce the prevailing poverty in these areas (Asfaw *et al.* 2012). Insufficient and ineffective extension service delivery has been identified as one of the main bottlenecks retarding the growth of rural cocoa-growing communities and the agricultural sector (Binam *et al.* 2008). High global demand for cocoa beans and low productivity by almost 90% of Ghanaian farms have necessitated the use of extension as a means of developing human capacity and providing financial support to farmers. Recent roles played by extension services go beyond technology transfer and improvement in production, including actual training, coaching, and working with farmers to make positive gains from the program. Thus, agricultural extension programs are mostly aimed at facilitating the development and improvements in the environment, poverty reduction, agricultural production and processing. As asserted by Feder *et al.* (2004), agricultural extension acts as a means for teaching large groups of farmers new technologies which will ultimately result in improved productivity and income. Also, extension acts as a way of developing a community through improving production skills and knowledge and linking farmers to markets (Bonye *et al.* 2012; Addai *et al.* 2014).

In line with the sustainable cocoa production policies, the Ministry of Food and Agriculture (MOFA), Ghana Cocoa Board (COCOBOD), and non-governmental organizations (NGOs) use extension programs to implement cocoa projects and reach out to many rural farmers. The NGO under study is Cooperative for Assistance and Relief Everywhere (CARE) International, prominent for supporting and building the capacities of smallholder farmers using extension programs. The Eastern Region is the site for one of their flagship programs known as the Cocoa Life Project (CLP) in the area of sustainable cocoa production. While targeting 3 500 cocoa farmers in five districts, the CLP extension service component has fundamental principles of building farmers' capacity to adopt good agricultural practices, providing farming incentives, and linking farmers to purchasing institutions. Considering the investment made, the value for money of the CLP becomes an important indicator the project sponsors would like to find out.

Extensive literature exists on the positive impacts of extension programs in agricultue (Belay 2003; Baffoe-Asare *et al.* 2013; Elias *et al.* 2013; Alemu *et al.* 2016; Ateka *et al.* 2019). However, in Azerbaijan, Guliyev *et al.* (2019) discovered that NGOs did not contribute to improving hazelnut farmers' production efficiencies. In Ghana, some researchers focused on the benefits derived from governments' cocoa extension programs, while others shared extensive knowledge on the rate of technology adoption and its improvement on farm productivity. Though the country is the second-largest producer of cocoa beans in the world (Fig. 1), there is a lack of extensive literature on the impact of extension service delivered by NGOs such as CARE International on smallholder cocoa farmers' productivity and income. A study on NGOs proposed here will help close the knowledge gap and serve as a guide for decision making by stakeholders in the agricultural sector. The study attempted to fill this gap by evaluating the impact of

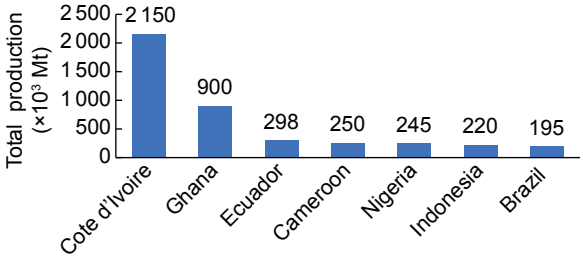

Fig. 1 Seven highest cocoa producers in the world (2017/2018). Source: Statista (https://www.statista.com/statistics/263855/cocoa-bean-production-worldwide-by-region/).

extension service delivery with specific reference to the CLP on cocoa farmers' productivity and income in the program's operational areas in the Eastern Region.

2. Data and methods

2.1. Study area

The cocoa landscape of three selected districts in the Eastern Region, Ghana was used to analyze the effects of the extension service delivered by the CLP on farmers' productivity and income. Three of the five districts serving as the program's operational areas, namely West Akim, Upper West Akim, and New Juaben, were selected as study areas. With a population of 2.6 million, the Eastern Region has an estimated annual cocoa yield of 96 639 metric tons and it is the third-largest producer of cocoa beans in Ghana. The three selected districts are dominated by rural communities with the majority operating as smallholders. Together, the districts have a total population of 379 076 (constituting 32.5% females and 67.5% males), of which the majority (97%) are engaged in small-scale crop farming (GSS 2017). The Eastern Region is characterized by low rainfall starting from mid-April but very heavy rainfall between May and August. The temperature averages 24.9–34.4°C, with an annual rainfall of 1 200–1 050 mm. The region is regarded as a fertile ground for cocoa cultivation because of the history of investment in cocoa production by development partners and governments. Most agricultural extension systems in the region just like any part of Ghana are supported by public government funds and projects are executed by civil servants such as agricultural extension workers who are tasked with reaching out to all categories of farmers within their respective catchment areas. The region has been of great concern to both the Ministry of Food and Agriculture and the Ghana Cocoa Board because its contribution to the country's annual cocoa production has decreased considerably, causing rural poverty.

2.2. Data collection

The study used primary data collected through a well-structured questionnaire during the 2017/2018 cocoa season. A three-stage sampling technique was used to select representative farmers and households for analysis. At the first stage, district-level sampling selected three out of five districts initially designated by CARE International as its ongoing program's operational area for the period 2012 to 2022. In the second stage known as the community-level sampling, four CLP operational communities were selected from each of the three districts. Also, three, four and five non-participating communities were selected from West Akim, Upper West Akim and New Juaben, respectively (Table 1). Thus, the present survey took place in 24 communities, 12 each from the project's operational and non-operational areas. The selected cocoa-growing communities are located far from each other because most cocoa farms require large hectares of land. With little interaction, the level of information sharing between program participants and non-participants which could introduce a potential source of bias in estimates is minimized. While most extension programs are tailored to meet the crucial needs of farmers, CLP objectives are somehow extensive making program participants not immediately grasp the knowledge been disseminated, which greatly reduces the accuracy of information shared with non-participants. At the final stage — farming household sampling, five or six households were selected from each participating community, and six to eight households from the non-participating communities. Specifically, the selection of program participants into the study was accurately facilitated by agricultural extension agents from both the Ministry of Food and Agriculture and the Ghana Cocoa Board working collaboratively on the CLP. Since all participating farmers were registered during program inception, secondary data from the program organizer were used to ascertain whether the right participants had been selected for the study. Non-participants were selected using methods such as random visits to their farms or houses, recommendations by other farmers, and the use of a list of registered farmers provided by the District Cocoa Board Office that records all the farmers actively participating in the government's agricultural subsidy programs.

A sample of 200 cocoa farm households which consisted of 82 participants and 118 non-participants was used. The selected sample represents almost 6% of the total cocoa farmers targeted by the CLP in the five districts. Moreover, a random sample of 20 farmers was used to pre-test the questionnaires for correcting order

Table 1 Selected districts and communities

Districts	Participating communities	Non-participating communities
West Akim	Ekwaso, Asumpa, Adeiso Asikasu	Akanteng, Osenase Kobriso
Upper West Akim	Obeng Yaw, Kyekyewere, Asikasu, Asuotwene	Amoakrom, Asuokam, Breman, Takorase
New Juaben	Akwadum, Suhyen, Asokore, Asuagya	Agya Owusu, Oyoko, Effiduase, Jumapo, Kofikrom

bias, wrong wording of key agricultural terms, and lack of understanding or misinterpretation. Key stakeholders such as district extension agents from both COCOBOD and MOFA, CLP coordinators, district agricultural directors, and cocoa purchasing agents were consulted to understand their expectations as to how the program can increase farm productivity and income of participating households.

Finally, the selected 200 cocoa farmers in the districts were asked to state their farming problems in a multiple response analysis. As shown in Fig. 2, almost 169 farmers (84.5%) stated financial constraint as their main bottleneck. The lack of proper institutional credit to rural cocoa farmers has brought a lot of deliberations among key stakeholders in the agricultural sector.

In dealing with this problem, the Ghanaian government has established rural and community banks in selected farming communities through the Bank of Ghana, specializing in providing credit to farmers. Current evaluations of the operation of these unit banks reveal that most of their loan portfolios have been offered to people engaged in trade, industrial activities, and real estate development. This negligence has deprived the agriculture sector of its 50% share of credit portfolio mandated by the Bank of Ghana before the establishment of these unit banks. Lack of extension services ranked the second on the list of barriers with 162 farmers (81.2%) making it clear that the absence of qualified extension agents in their district had constrained their farming activities over the years. This comes as no surprise especially when cocoa extension agents lack the proper means of transportation, coupled with many cocoa farmers living in deprived communities lacking good roads and social amenities.

Some farmers further stated that due to the lack of government's subsidized farming inputs coupled with the hard-economic situation in the country, they were unable to purchase and use the requisite amount of cocoa fertilizers and other requisite agrochemicals on their farms. This problem has culminated in the significant loss of cocoa yield due to pests, diseases, and insect attack. In support of this, 72 and 70% of the farmers stated that biological hazards (pests, insects and diseases) and the country's fluctuating prices of farming inputs were the bane of effective cocoa production, respectively. However, apart from extension education, another vital objective within the operating framework of the CLP extension service is to provide financial incentives to participating farmers. The cocoa sector in Ghana over the years has benefited from numerous foreign interventions in the form of NGO projects (Table 2) that aimed at sustainable cocoa production, ecosystem conservation, and poverty alleviation among deprived cocoa farming communities.

2.3. Extension services delivered

The services delivered as part of the extension program come in various forms and all are tailored to best meet the needs of participating cocoa farmers in the selected program operational areas. While the dissemination of requisite information may be hindered by several factors such as high illiteracy rate of farmers and the proximity of extension agents to farming communities, the program's principle was to operate with a significant number of extension agents who are professionally trained, motivated, and highly qualified to deliver efficient and cost-effective cocoa extension services which align with the program's objectives. Table 3 summarizes all the activities undertaken during the project's implementation period. Specifically, methods such as rallies, farm visits, field demonstrations, community meetings, community radio broadcasting, and home visits were extensively used to educate farmers on good agricultural practices.

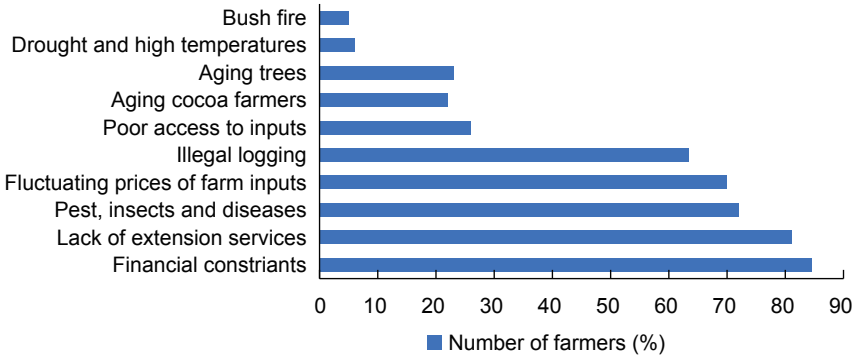

Fig. 2 Farmers' farming problems (multiple response analysis, *n*=200).

Table 2 Some selected non-governmental organizations (NGOs) involved in cocoa intensification projects in Ghana

Name of NGO	Project name	Task description	Character of the project
Hershey	21 Century Cocoa Sustainability Strategy	Aid cocoa-growing communities to grow sustainable cocoa and use mobile technology for farming	Training on improved yield and agricultural practices
Wetlands International/ 33 Forest Capital	33 Forest Capital Cocoa & REDD+ Project in Ghana	Cocoa forests protection and improving the sustainability of the Cocoa supply chain	Practical implementation and training on improved agricultural techniques
Solidaridad West Africa	Ahansucofa Project	Aid farmers to adopt sustainable farming practices and increasing cocoa production and farmers' income	Certification training, capacity building, and subsidy provision to farmers
Cargill/Solidaridad	The Cargill Cocoa Promise	Aimed at improving the long-term sustainable production of cocoa and improving farmers' welfare	Training and financial support, and assisting farmers to gain cocoa certification status
Rockefeller Foundation / Moore Foundation	Cocoa Carbon Initiative; promoting Climate SMART Cocoa in Ghana	Tackling the role of cocoa farming in deforestation and forest degradation	Extension training, loan guarantees, insurance products, and input supply services
Conservation Alliance	Cocoa Agroforestry Project	Protecting the cocoa production landscape through the adoption of sustainable cocoa production practices	Training and capacity building in sustainable agriculture practices, and farmer organization empowerment
World Cocoa Foundation (WCF)	Cocoa Livelihoods Program (CLP)	Doubling the income of smallholder cocoa-growing households	Training, financial support, and practical implementation on the use of good practices
Netherlands Development Organisation	Cocoa Eco Project	Increasing cocoa productivity, income levels, and livelihood of targeted farmers while sustaining the ecosystem	Training and capacity building in sustainable agriculture practices
Agro Eco-Louis Bulk	Organic Cocoa Farmers Project	Adopting organic systems to produce high-quality organic cocoa beans	Training, financial support, and practical implementation on the use of good practices

The core activities implemented were nursery practices which included site selection, land preparation, nursing of cocoa seedlings, maintenance of the nursery, provision of shade trees, and seedling transplanting. Participants were also educated on forest conservation and general ecosystem management methods, bush fire prevention and control strategies, and adoption of sustainable cocoa production practices. Farming subsidies in the form of fertilizers, pesticides, fungicides, and farming equipment were distributed to participants at no cost. Farmers also received basic training in using and maintaining sophisticated farming equipment such as tractors, mowers, mechanized sprayers, and fogging machines.

Market linkages by extension organizers played a significant role in improving the sales of cocoa beans to Produce Buying Companies (PBCs) because farmers are directly linked to prospective buyers who are ready to purchase and transport the cocoa beans from the farmers' farms to their warehouses. The provision of farming credit to participating farmers will enable them to pay for farming labor, purchase fuel for running farming machines, and sometimes spending the rest on maintaining the farm. However, access to institutional farming credit in rural cocoa-growing communities in Ghana is constrained by many conditions. It is worth noting that all activities delivered by the project were perceived to improve the total cocoa yield of participating farmers.

2.4. Model specification

Using Stata 14.0 Software, this study assumed a positive association between participating in the CLP extension service and farm productivity and income. The two can be related to a set of institutional, socio-economic, and farm factors. In determining the effect of the CLP extension service on farm productivity and income, this study first used regression on covariates, then accounted for bias arising from selection by adopting the regression propensity scores. The Heckman's treatment effect model which is an extension of Heckman's two-stage model was used as a robustness check. In the first instance, these outcome variables (cocoa yield, farm

Table 3 Services delivered during the Cocoa Life Project (CLP) extension

Task description	Core activities	Duration (Weeks)	Co-actors
Tackling the role of cocoa farming in deforestation and forest degradation Bush fires detection, management, and control strategies Protecting the cocoa production landscape through the adoption of sustainable production practices	Training Capacity building	5	Ghana Cocoa Board, Forestry Commission
Linking cocoa farmers to Produce Buying Companies (PBCs) Negotiating the optimum sales price on behalf of participating farmers	Market linkages Training	3	Ministry of Food and Agriculture, Cocoa Marketing Board
Training on the usage of mechanical sprayers Provision and distribution of cocoa fertilizers to participants Repair and Maintenance of basic farming machinery	Subsidy Equipment Training	2	Ministry of Food and Agriculture, Ghana Cocoa Board
Farm records keeping Basics in marketing and accounting practices English language studies	Training	3	Ministry of Food and Agriculture
Farmer group formation and its benefits Introduction to group credit borrowing from rural and community banks	Subsidy Training	2	Rural and Community Banks, Ghana Cocoa Board
Viable seed identification for planting Seedling nursing Seedbed preparation Erection of nursery shade nets Tree pruning	Training	3	Cocoa Seed Production Division
Seedling transplanting Land preparation Pest and disease control Fertilizer and pesticide applications Identification of disease-infested trees	Training	2	Cocoa Health and Extension Division, Cocoa Research Institute
Provision of farming credit Distribution of farming equipment Distribution of personal protection equipment	Subsidy	2	CARE International
Processes and procedures involved in cocoa harvesting, pod breaking, drying, grading, and bagging Knowledge in certification status development	Training Certification	3	Quality Control Company, Cocoa Marketing Company Limited
Construction of farm storage facilities Soil erosion management Introduction to integrated crop, pest, and diseases management	Training Capacity building	3	Ministry of Food and Agriculture, Cocoa Marketing Board, CARE International

income, household income, and per capita household income) were considered as a linear function of a vector (X_i) representing institutional, farm-related, and socio-economic factors. The best way of evaluating the effects of the CLP extension service is to incorporate farmers' choice of participating in the program into the outcome equation. This is denoted by AC_i, where 1 and 0 accurately represent participating and non-participating choices, respectively. The Ordinary Least Squares method can then be used in the estimation process. The equation is specified as:

$$Y_i=\beta+\alpha_i AC_i+\delta_i X_i+\varepsilon_i \quad (1)$$

where, Y_i is a set of outcome variables; AC_i is a dummy variable for farmers' participation choice; X_i is a set of independent variables; α_i and δ_i are parameters to be estimated; ε_i is the error term.

The estimates of α_i can predict the effect of AC_i on outcome variable Y_i. However, the use of OLS in estimating the parameters in eq. (1) will generate biased results since it takes AC_i to be exogenous and random. Since the selection of participating farmers into the CLP extension service is non-random, the AC_i is considered endogenous in this case. However, the problem of selection bias may arise where the farmers may decide whether or not to participate in the program due to inequalities in economic and social status. Endogeneity issues may exist as the program may be targeting farmers with certain characteristics such as very poor households, lack of access to credits, smallholders, etc. The resulting biased estimates of AC_i's coefficients that measure the true effects of program participation on outcome variables may become problematic. Moreover, a critical source of bias can emanate from the selection of observables and un-observables. Whereas the former is controlled in the model by adding a set of variables, the latter is difficult to control, rendering the estimates of α_i bias. This study,

therefore, used a combination of econometric methods in dealing with the issues of selection bias.

First, regression on covariates, applied by Alemu *et al.* (2016), involves the introduction of observable covariates to account for potential selection bias due to selection on observables. Eq. (1) is re-specified as:

$$Y_i=\beta+\alpha_i AC_i+\chi_i M_i+\delta_i X_i+\varepsilon_i \quad (2)$$

where, M_i is a vector to control for selection bias and χ_i represents parameters to be estimated. The rest are already defined.

The second approach used by Elias *et al.* (2013) and Alemu *et al.* (2016) is the regression on propensity score where estimates of conditional probabilities of participating in the CLP extension is used in the regression model as a control variable. The bias coming from the selection of observables is reduced by the propensity scores generated in a probit model. The new model is:

$$Y_i=\beta+\alpha_i AC_i+\phi_i PS_i+\chi_i M_i+\delta_i X_i+\varepsilon_i \quad (3)$$

where, ϕ_i is the propensity score estimates and $PS_i=P(AC_i=1/X)$.

The Heckman's treatment effects model widely used for dealing with selection bias was adopted as the third estimation method. As asserted by Greene (2003) and Bravo-Ureta (2012), the procedure produces consistent estimates by correcting for biases emerging from unobserved factors using predicted values of the dependent variable. A probit model is used to estimate the selection equation and for generating the Inverse Mills Ratio (IMR) which is used as a limiting factor in the subsequent estimations. The issue of selection bias is dealt with by incorporating the IMR into the outcome equation as an additional regressor (Bushway *et al.* 2007; Heckman 2013). By this means, the effects of farmers' participation in the CLP extension service on outcome variables can be measured. The model proceeds in two steps. The first is a selection equation in the form of a probit model, which is represented as:

$$AC_i=\beta+\delta_i X_i+\varepsilon_i \quad (4)$$

where, AC_i is an endogenous variable and X_i represents a set of exogenous variables, with the former measuring farmers' participation, and the latter determining household selection into the program. ε_i and δ_i represent the error terms and parameters to be estimated, respectively. The new equation is:

$$Y_i=\beta+\alpha_i AC_i+\delta_i X_i+\varepsilon_i \quad (5)$$

where the welfare effect from the extension program is measured by α_i. The IMR is further generated and added to correct for biases arising from self-selection. The IMR is generated by:

$$\lambda_i=\frac{\phi(-\delta_i X)}{1-\Phi(\delta_i X)} \quad (6)$$

From eq. (6), the cumulative and probability density functions are denoted by Φ and ϕ, respectively. The new equation after adding the IMR to eq. (5) is specified as:

$$Y_i=\beta+\delta_i X_i+\alpha_i AC_i+\gamma_i \lambda_i+\mu_i \quad (7)$$

Here, γ_i and μ_i are the estimates of IMR and two-sided error, respectively. The rest are already defined. A non-significant coefficient of the IMR indicates the absence of selection bias and *vice versa*.

3. Results and discussion

3.1. Description of variables

Presented in Table 4 is a summary of the variables and their respective hypothesized effects. The dependent variables are cocoa yield, farm income, total household income, and household per capita income. The overall changes to these outcome variables were measured by the introduction of a set of independent variables appropriately classified as socio-economic factors, farm factors, and institutional factors. The yield of cocoa was measured as the weight in kilograms of dried beans per hectare of farmland. A bag of cocoa is 64.0 and 62.5 kg, respectively, at farm gate and during shipping by the Ghana Cocoa Board. The price in the commodity market has recently increased by 9.9%, raising the sales price for a bag from 90 to 100 USD. Total household income and per capita income were also considered since they can accurately reveal the financial situations of the selected farming households involved in the study.

3.2. Descriptive statistics

Table 5 depicts the descriptive statistics of unmatched and matched dependent variables, and explanatory variables (socio-economic, farm, and institutional factors) used in accessing the benefits derived from the CLP extension service. As observed, the mean cocoa yield (pooled) for the unmatched sample was 362.40 kg ha^{-1}, which was less than government's estimate of 400 kg ha^{-1}, suggesting that strategic policies that enhanced sustainable cocoa production in the region was mandatory. Results from previous studies have also revealed that the yield of cocoa grown in many Ghanaian farms is much lower than that grown in other producing countries such as Indonesia, Malaysia, Brazil, and Ivory Coast (Osei-Bonsu and Anim-Kwapong 1998; Adomako *et al.* 2001; Asase *et al.* 2010). Similarly, the study of Appiah *et al.* (2000) further stressed that the Ghanaian cocoa landscape is characterized by low productivity which has adversely affected total farm income, total household income, and per capita household income of farmers. Moreover, for the unmatched sample, the

Table 4 Description of variables and their hypothesized effects

Variables	Description	Hypothesized effects
Dependent variables		
Cocoa yield	Yield of cocoa (kg ha^{-1})	
Farm income	Total income from cocoa sales (USD ha^{-1})	
Total household income	Total household income from cocoa sales and other activities (USD)	
Total household per capita income	Total household per capita income (USD)	
Explanatory variables		
Socio-economic factors		
Age of household head	Age of household head in years	+, –
Gender of household head	1 if household head is male, 0 otherwise	+
Secondary occupation	1 if engaged in a secondary occupation, 0 otherwise	+
Experience in cocoa farming	Years of farming experience of the head	+
Formal education	Years of formal education of the head	+
Household size	Number of people in the family	+
Farm factors		
Farm size	Size of farm in hectares	+
Number of cocoa farms	Count of total cocoa farms	+
Institutional factors		
Farmer-based organization (FBO) membership	1 if farmer is member of FBO, 0 otherwise	+
Access to credit	1 if farmer has access to credit, 0 otherwise	+
Participation in cocoa disease program	1 if farmer participated in government's mass spraying program, 0 otherwise	+
Distance to cocoa buying agents	Distance from farm to buying agents (km)	+, –
Access to subsidized inputs	1 if farmer received government's subsidized farming inputs, 0 otherwise	+

study found no significant difference between the mean yield of program participants (362.40 kg ha^{-1}) and non-participants (329.47 kg ha^{-1}). This might be due to the slow nature of technology adoption, and the over-concentration on earning secondary income among the program participants. However, farmers' successful participation in the extension program and the influence of the program's activities on their farm output and income depended on a set of factors that this study sought to understand. The mean (pooled) farm income per hectare obtained solely by selling cocoa beans to cocoa purchasing agents was 450.57 USD. Also, farm income per hectare showed an 18.73% difference, significant at 5%, in favor of the program participants. This can be ascribed to the fact that participants had easy access to cocoa buying agents, hence reducing transportation and other auxiliary costs which might be incurred by non-participants. Similarly, in India, a study conducted by Barman and Deka (2019) attributed the variations found in the farm incomes of selected farmers to whether they actively participated in government's organized extension programs. In the context of this study, linking farmers to certified cocoa buying agents aligned with one of the objectives of the CLP extension service. By this means, farmers were not outwitted by cocoa purchasing agents in the weighting process where calibrations on the scales are tampered with. This observed difference also came as a result of participants acquiring essential knowledge in basic agronomic practices to produce high-quality cocoa beans conforming to the certification process established by the COCOBOD. Several studies have also attributed the improvement in farmers' farming knowledge to their active participation in extension programs (Karbasioun *et al.* 2007; Michailidis 2007; Ogunbameru *et al.* 2013). Total household income represents the summation of households' revenues from cocoa sales and secondary sources such as salaries and wages, and sales from poultry and livestock and other crops. The mean total household income was 2 980.53 USD and the mean per capita income was 670.58 USD during the study period.

The value of total household income showed a 22% variation (at a 10% significance level) in favor of the program participants over non-participants. Household per capita income (total household income against family size) was significant at 1%, 868.11 USD (GH₵ 5 032.20), and 473.06 USD (GH₵ 2 742.23) benefiting the extension participants. This was expected due to the difference in household size and total household income. At a 1% significance level, the mean age of program participants was 41.34 years while that of non-participants was 55.24 years, indicating the importance of age in farmers' decision making in joining organized extension programs. Males were dominating in cocoa cultivation in the selected districts because males constituted 89 and 65% of the

Table 5 Descriptive statistics of cocoa farm households

Categories	Unmatched sample (*n*=200)			Matched sample (*n*=164)		
	Pooled	Participants	Non-participants	Pooled	Participants	Non-participants
Dependent variables						
Cocoa yield	345.34	362.40	329.47	342.40	346.21	307.24
	(32.14)	(72.78)	(29.87)	(61.13)	(39.15)	(29.77)
Farm income	450.57	534.99**	366.15	420.57	454.02	334.16
	(28.35)	(97.78)	(38.23)	(32.15)	(57.34)	(45.14)
Total household income	2980.53	3636.06**	2325.39	2671.23	2915.04	2243.19
	(365.34)	(147.91)	(89.51)	(271.15)	(107.72)	(69.74)
Total household per capita income	670.58	868.11***	473.06	601.28	621.21	598.25
	(241.78)	(113.02)	(65.13)	(172.52)	(184.02)	(74.73)
Explanatory variables						
Socio-economic factors						
Age of household head	48.29	41.34***	55.24	46.14	47.83	49.28
	(12.78)	(9.82)	(11.21)	(8.95)	(4.67)	(9.83)
Gender of household head	0.75	0.89	0.65	0.68	0.69	0.64
	(0.45)	(0.03)	(0.02)	(0.18)	(0.21)	(0.12)
Secondary occupation	0.83	0.72	0.94	0.68	0.79	0.65
	(0.69)	(0.14)	(0.04)	(0.04)	(0.15)	(0.10)
Experience in cocoa farming	24.54	19.03	30.05	20.12	19.17	22.85
	(12.34)	(7.99)	(8.05)	(9.34)	(6.34)	(6.45)
Formal education	3.56	5.04	2.08	3.31	4.21	1.36
	(1.13)	(0.12)	(0.26)	(0.95)	(0.45)	(0.22)
Household size	6.01	4.07	8.01	5.12	4.03	5.97
	(2.13)	(0.10)	(2.04)	(1.45)	(0.34)	(1.01)
Farm factors						
Farm size	2.72	2.10***	3.34	2.03	1.68	2.01
	(1.06)	(0.18)	(0.31)	(0.65)	(0.43)	(0.87)
Number of cocoa farms	2.07	2.74	1.41	1.94	1.95	1.91
	(1.12)	(0.34)	(0.11)	(0.83)	(0.84)	(0.82)
Institutional factors						
Farmer-based organization (FBO) membership	0.68	0.87**	0.49	0.54	0.55	0.48
	(0.32)	(0.07)	(0.01)	(0.12)	(0.13)	(0.14)
Access to credit	0.32	0.45**	0.19	0.26	0.28	0.21
	(0.13)	(0.09)	(0.04)	(0.12)	(0.13)	(0.11)
Participation in cocoa disease program	0.81	0.95*	0.67	0.72	0.82	0.79
	(0.28)	(0.06)	(0.04)	(0.11)	(0.25)	(0.23)
Distance to cocoa buying agents	21.98	24.74*	19.23	19.32	20.34	19.34
	(8.52)	(7.32)	(8.45)	(6.54)	(7.98)	(7.56)
Access to subsidized inputs	0.29	0.31	0.27	0.24	0.28	0.26
	(0.06)	(0.08)	(0.04)	(0.03)	(0.05)	(0.06)

***, ** and * denote significance at 1, 5 and 10%. Enclosed in parentheses are standard deviations (1 USD=5.72 GH₵).

participants and non-participants, respectively. This finding comes as no surprise because males are mostly considered to be decision-makers in African society as they have the requisite strength to endure all the tedious work associated with farming. Cocoa cultivation was not the only activity in the area, as farmers were also actively engaged in other secondary activities. The study also discovered significant differences in farm size, farmer-based organization membership, access to credit, participation in government's mass farm spraying program, and distance to cocoa buying agents between the participants and non-participants.

After matching the samples, all the 82 extension program participants were paired with 82 non-participants out of the 118. Similar to the specifications adopted by Leuven and Sianesi (2003), an independent two-sample *t*-test was conducted before and after matching to appropriately gauge if the means of observed characteristics existing between the participants and non-participants are equal. Most of the differences in the unmatched sample were significant. Since the means difference between participants and non-participants were insignificant after matching, it can be accurately stipulated that the balancing properties of covariates are satisfied in the study. Caliendo and Kopeinig (2008) stated that when the covariate means for the treated and

control groups in a sample are equal then a good match is said to be attained. Finally, Rosenbaum and Rubin (1983) advised on performing a *t*-test for any insignificant differences because if the matching covariates are randomly distributed, an insignificant level must be achieved. Figs. 3 and 4 present the achieved region of common support among extension participants and non-participants due to sufficient balancing of characteristics. However, without controlling for selection bias in the estimation process, results from the descriptive statistics cannot fully justify the true effect of participation in the CLP extension service on selected outcome variables.

3.3. The determinants of farmers participation in the CLP extension service

The probit model results (Heckman's first stage) for the determinants of farmers' participation choice in the CLP extension service are presented in Table 6. A significant Wald's test value of 25.42 supports the robustness of the data used. From the results, farmers' decision to participate in the extension program was positively influenced by the experience of the household head, partaking in cocoa disease and pest control program (CODAPEC), and farmer-based organization (FBO) membership. However, the probability of participating was negatively influenced by age of household head, engagement in secondary occupation, and access to credit. The age of household head with a significant and negative coefficient suggests that younger farmers were more willing to learn new technologies and practices that can increase farm productivity than their older counterparts. This was in line with the results indicated previously in Table 5 that the mean age of non-participants was higher than that of participants, suggesting that older farmers were not interested in acquiring any new knowledge in farming. This is very common in many Ghanaian agricultural setups because older farmers are very weak and mostly consider any activity which will move them away from their farming business as non-profitable. Most older farmers are of the notion that their traditional ways of cocoa cultivation are best suited for the geographical environment they lived, and hence, the advice from extension agents who are less familiar with their farming environment will be detrimental to their farming business.

Consistent with this study is that of Kumba (2003) in Namibia which discovered that older farmers were unwilling to join extension services delivered by the Ministry of Agriculture in different parts of the country. Additionally, this result is consistent with the studies reported by Genius *et al.* (2006) and Elias *et al.* (2013) but contradicts the findings of Mendola (2007) and Tiwari *et al.* (2008). Similar to the findings of Martey *et al.* (2013) and Nwaobiala (2014), the gender of the representative household heads showed a positive

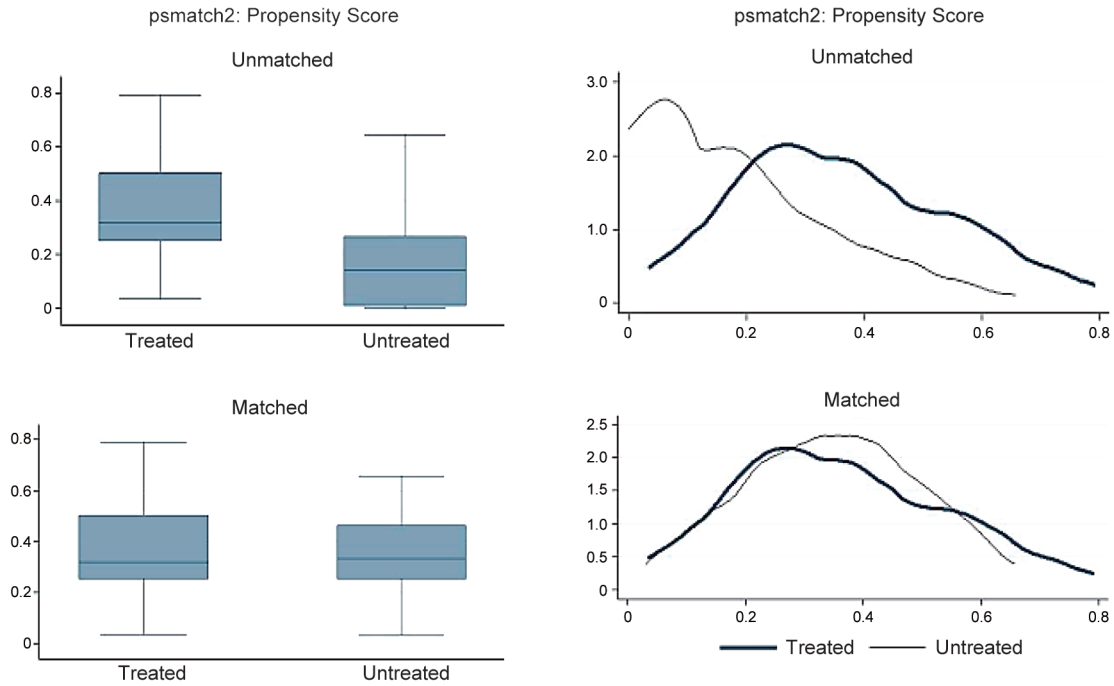

Fig. 3 Box plot and probability distribution before and after matching.

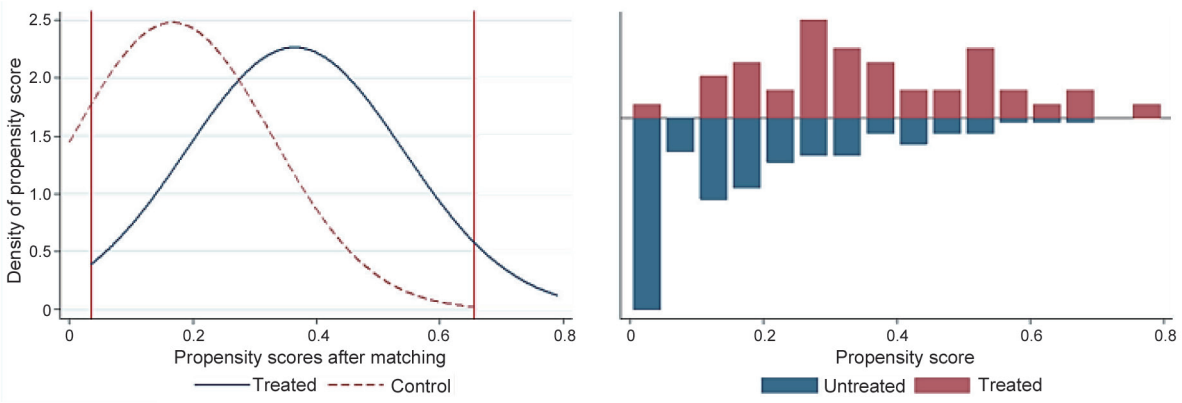

Fig. 4 Imposed region of common support.

Table 6 Determinants of farmers participation in the Cocoa Life Project (CLP) extension service (Heckman's first stage)

Variable	Coefficient	SE	*Z*-stats.
Constant	–2.147***	0.279	–8.445
Age of household head	–0.142*	0.013	–1.923
Gender of household head	0.112	0.321	0.348
Secondary occupation	–0.241*	0.017	–1.176
Experience in cocoa farming	0.014*	0.132	0.106
Formal education	0.046	0.012	3.833
Household size	0.431	0.124	1.795
Farm size	0.121	0.103	1.174
Number of cocoa farms	0.203	0.198	1.025
Access to credit	–0.213**	0.110	–3.936
Farmer-based organization (FBO) membership	0.613***	0.274	4.237
Participation in cocoa disease program	0.428***	0.311	3.376
Distance to cocoa buying agents	3.066	1.79	1.71
Access to subsidized inputs	0.975	0.639	1.53
Model Diagnostics			
LR Chi^2	26.31		
Pseudo R^2	0.602		
Prob>Chi^2	0.000		
Wald Chi^2	25.42***		
Observations	200		

***, ** and * denote significance at 1, 5 and 10%.

coefficient, but it was not a significant determinant of their participation choice in the extension program. In line with the work of Akrofi-Atitianti *et al.* (2018), secondary occupation showed a negative and significant coefficient, suggesting that compared with those without a secondary occupation, farmers earning extra income from non-cocoa related activities were less likely to participate in the extension service due to lack of time and their ability to meet all farming and household needs. As expected, experience in cocoa farming positively influenced extension participation because farmers were eager to learn new farming methods for increasing yields. This is true especially at instances where NGOs decide to disburse farming subsidies such as cocoa fertilizers, pesticides, fungicides, and improved variety of planting materials during its extension programs. Since farmers are always prepared to receive free services from NGOs, the experienced ones can easily judge the perceived outcome of a program before deciding to join. Contrary to expectations, years of formal education, though with a positive coefficient, was not a significant determinant of farmers' participation choice. Education can improve the thinking ability of farmers and help them in making pragmatic farming decisions in the future, however, the current study did not follow such trend. In support of this, Attipoe *et al.* (2020) stipulated that most cocoa farmers in Ghana are illiterates, hence making it difficult for extension agents to appropriately convince them into joining extension programs. Moreover, household size, farm size, the number of cocoa farms owned, access

to subsidized inputs, and distance to cocoa buying agents did not significantly influence extension service participation. Farmers already having access to credit from sources different from the CLP extension were keen on diverting to non-agricultural related activities to generate a quick return on investment for repayment. However, the finding contradicts that of Danso-Abbeam *et al*. (2018) that access to credit motivates farmers' participation in extension programs. Similar to the findings of Pender *et al.* (2006) and Abebaw and Haile (2013), FBO membership was positive and significant in determining extension program participation due to the good advice from agricultural extension agents, and the ease of dealing with an organized group by the program organizers. Finally, farmers participating in governments' sponsored mass spraying program, a plan to completely eradicate cocoa pests and diseases that cause 40% of annual losses (Baah and Anchirinah 2011; Akrofi *et al.* 2015), had a high probability of participation due to the additional benefits leading to an increase in farm productivity.

3.4. The effects of CLP extension delivery on cocoa yield, farm income, and household income

The estimated results for the effects of participation in the CLP extension service on outcome variables are presented in Table 7. The three models previously discussed were extensively used to highlight the effects of the extension program on outcome variables, thereby indicating the robustness of the estimates. The results from the different models revealed that the CLP extension service contributed positively to cocoa productivity and income in the study area.

Specifically, the estimated results showed that the extension program had a significant and positive effect on cocoa yield using the Heckman model but not in the other two models. All variables used in the analysis were in their logarithmic terms. Quantitatively, the result indicated that program participation increased farmers' cocoa yield by 14.3%. This result contradicts that of Feder *et al.* (2004) who found no contribution emerging from extension program participation on farm productivity. However, the finding supports some other studies (Davis *et al.* 2012; Elias *et al.* 2013) which also reported a positive effect of participation in extension services on farm yield. Other researchers have also tried to demonstrate the impact of extension modules implemented by non-governmental institutions in the form of farmer field schools on various arable crops. For example, McGarry (2008) and Meti (2007) measured the impact of farmer field schools on implementing integrated pest management (IPM) programs for cabbage and cotton production and discovered a positive association between extension participation and farmers' yield. The effects on farm income showed an increase of 25.1 and 42.9% when estimated with regression on propensity scores and the Heckman's model, respectively. This difference was expected as Heckman's model and regression on propensity scores corrected the biases arising from unobserved factors and observed covariates, respectively. Furthermore, the increase in farm income might be attributed to the program's objective of linking farmers to the output market such as certified Produce Buying Companies (PBCs) where harvested cocoa beans are purchased on a timely basis. Consistent with this finding is the work of Baiyegunhi *et al.* (2019) in South Africa, Ballantyne (1987) in Britain, and Anang *et al.* (2020) in Ghana, which concentrated on both the farm-level technology adoption by farmers and the positive effect of extension program on farm-level income. Across all models, program participation led to an increase in total household income by 46.1, 31.7, and 69.3%. Similarly, Elias *et al.* (2013) discovered an increase of 17.9 and 6.5% in total household income for participating in an extension program using Heckman's model and Ordinary Least Square, respectively. The results further support the findings of Akrofi-Atitianti *et al.* (2008) and Davis *et al.* (2012) on positive gains made by farmers from participation in extension programs. The effect of the CLP extension on household per capita income was positive and significant across all models due to the smaller household size coupled with participants' large total farm income. Participation increased household per

Table 7 Effects of Cocoa Life Project (CLP) extension service on cocoa yield, farm income, and household income

Outcome variables	Coefficient		
	Regression on covariates	Regression on propensity scores	Heckman's treatment effects
Cocoa yield (kg ha^{-1})	0.102 (0.123)	0.030 (0.288)	0.143*** (0.017)
Farm income (USD ha^{-1})	0.221 (0.201)	0.251** (0.072)	0.429** (0.111)
Total household income (USD)	0.461*** (0.058)	0.317*** (0.028)	0.693*** (0.136)
Total household per capita income (USD)	0.412** (0.122)	0.304* (0.117)	0.753*** (0.181)

***, ** and * denote significance at 1, 5 and 10%. Enclosed in parentheses are standard errors.

capita income by 41.2, 30.4, and 75.3% across the three models.

3.5. Additional factors affecting households' farm income levels

Besides farmers' participation in the extension program and its subsequent effect on income levels, other explanatory variables were perceived to further influence farm income. The results from the three models depicting these influential variables are presented in Table 8. The significant IMR value of 0.618 used in correcting for selection bias supports the use of Heckman's model. The absence of multicollinearity is indicated by the low variance inflation factor (VIF) coefficients of 1.242 and 1.981 using regression on covariates and propensity scores, respectively. The low Chi^2 values from the Cook Weisberg/Breusch-Pagan test further shows that the estimates are free from heteroscedasticity. The estimated results showed that the number of cocoa farms owned by farmers and participation in secondary occupation significantly and negatively affected farm income across all the three models.

Practically, farmers owning more cocoa farms were supposed to be wealthier than their counterparts with fewer farms, however, the results from this study indicated otherwise. Perhaps this is attributed to the fact that farmers with many farms may have inadequate resources to properly take care of those farms. Okoffo *et al.* (2016) explained that to accrue higher income from cocoa cultivation, the production system employed by farmers require all-year-round farm maintenance in the area of fertilizer application, weed control, fungicide, and pesticides application. Moreover, participating in secondary occupations apart from cocoa farming generates secondary income but reduces active engagement in organized extension programs. The overall effect on cocoa farm revenue was negative because farmers were busy taking care of attractive businesses that generate a better return on investments as compared to cocoa farming which was affected by the perils of the weather. This assertion might not always be true because the study of Wambugu *et al.* (2018) among Kenyan maize farmers argued that non-farm incomes played a central role in farm investments because it cushioned farmers against unforeseen risks. Also, based on the estimation method used, the age of household head, farming experience, and household

Table 8 Factors affecting household income across the three models (log of farm income as dependent variable)

Variables	Regression on covariates		Regression on propensity scores		Heckman's treatment effects	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Constant	4.562***	0.235	6.518***	0.435	5.077***	0.102
CLP extension	0.221	0.201	0.251**	0.072	0.429***	0.111
CLP propensity score			3.132**	0.715		
Age of household head	0.133	0.078	0.223***	0.013	0.331***	0.015
Gender of household head	0.174	0.143	0.197	0.135	0.213	0.117
Secondary occupation	–0.213**	0.004	–0.234***	0.017	–0.312***	0.010
Experience in cocoa farming	–0.015	0.073	0.063*	0.005	0.103***	0.011
Formal education	0.071	0.046	0.033	0.029	0.053	0.012
Household size	0.136	0.106	0.232***	0.022	0.251***	0.028
Farm size	0.131***	0.021	0.143**	0.013	0.322**	0.005
Number of cocoa farms	–0.012*	0.001	–0.021**	0.002	–0.113***	0.010
Access to credit	0.073	0.032	0.327***	0.025	0.358***	0.004
Membership of FBO	0.432	0.325	0.321	0.204	0.231	0.186
Participation in cocoa disease program	0.029	0.021	0.062	0.058	0.343***	0.034
Distance to cocoa buying agents (km)	0.425	0.312	0.314	0.201	0.254	0.154
Access to subsidized inputs	0.373	0.238	0.396	0.295	0.296	0.677
Model diagnostics						
Adjusted R^2	0.453		0.593			
λ (IMR)					0.618***	0.103
Cook Weisberg/Breusch-Pagan test						
Prob>Chi^2	0.000		0.001			
Chi^2	0.319		0.105			
VIF (mean)	1.242		1.981			
Observation	200		200		200	

***, ** and * denotes significance at 1, 5 and 10%.

size were the possible socio-economic factors positively affecting households' farm income. The significant and positive effect of farm size on farm income across all the three models highlighted the importance of farm size in cocoa production. Consistent with the study of Attipoe *et al.* (2020), farmers' access to institutional credit had a significant and positive effect on farm income using regression on propensity scores and Heckman's method because it allowed farmers to purchase all relevant farming inputs and apply them at the right quantity and time. Only Heckman's method indicated a positive association between farmers' participation in government-sponsored cocoa disease and pest control program and households' total farm income.

3.6. Potential NGOs activities constraining farmers extension program participation

The most relevant question that could appropriately inform policy analysts during the performance evaluation of the activities of non-governmental organizations is: how has the implemented extension program caused significant changes in participants' behavior? However, second to this question is the most forgotten assessment of the participation behavior of farmers in the program. Participation in most non-governmental extension programs is based on farmers' willingness, and decisions not to participate come with many reasons which are vital for researchers to reveal. To gain insight into the most compelling elements that farmers consider before joining NGO interventions, this study explicitly adopted the five-point Likert scale (1=not critical, 2=less critical, 3=neutral, 4=critical, and 5=very critical) to rank those elements farmers consider before joining the program. Table 9 below displays the perceived constraints for farmers to participate in the extension program.

Table 9 Mean score of factors affecting farmers participation in non-governmental organizations (NGOs) programs

Constraints affecting farmers	Mean	SD
Late delivery of subsidies	4.94	1.20
Low awareness or sensitization	4.83	0.78
Political party discrimination	4.72	0.90
Lack of sustainable knowledge development and training activities	4.56	1.14
Poor organization of training during the program	4.45	1.23
Rampant changes in training schedule	4.34	1.21
Erroneous farmer registration list	4.23	1.01
Irregular and inconsistent communication	4.11	1.02
Lack of collaboration with the Ministry of Food and Agriculture	4.02	1.03
Farmers' low educational level	3.24	1.62
Unknown organization structure/ contact person	3.18	1.08
Programs and activities without farmers' association	3.01	1.01

Results indicated that the mean scores ranged from 4.94 to 3.01. Nine out of 12 factors were discovered to be the bane to farmers' participation in extension programs because their means were above the 3-point Likert mark. The late delivery of subsidy was selected as the highest and most critical constraint (mean=4.94). As asserted by Chiona *et al.* (2014), late delivery of inputs to program participants can impede the progress of agriculture because most farming systems are dependent on the scheduled application of inputs. Besides the aforementioned problem, the majority of farmers lost trust under such circumstances and this would lead to a radical decision of shunning subsequent extension programs. The low level of program sensitization made many farmers not to recognize the benefit of participation. Another major challenge was the lack of sustainable knowledge development and poor organization of training. As asserted by Guliyev *et al.* (2019), many agricultural extension programs were poorly managed and new technologies introduced to farmers were often neither beneficial nor supported under their current farming conditions. Another major challenge was the rampant rescheduling of training programs coupled with inconsistent communication which adversely disturbs farmers' daily plans. It is believed that proper assessment of these problems before program implementation will not only increase farmers' active engagement but also contribute immensely to improving agricultural productivity.

3.7. Policy implications for future cocoa production

In line with the government's Food and Agricultural Sector Development Policy (FASDEP II) aimed at transforming the agricultural sector for increased productivity, promoting economic development, creating employment, and ensuring food security, extension services have been identified as one of the most desirable means of achieving these results. Although the cocoa sector over the years has attracted many interventions especially those from NGOs, all aiming towards sustainable cocoa production and farmers' welfare, little can be said about the positive outcome of their programs since total cocoa production continues to decline and farmers' livelihoods have been negatively affected. This study put forward strong proof of the role of NGOs and their possible contributions to increasing cocoa production and household income in Ghana. The current findings provide crucial understanding for policymakers in the cocoa sector to adequately develop and implement pragmatic policies that

seek to promote positive outcomes in Ghana. Moreover, transparent policy instruments directed at increasing both NGOs and cocoa farmers' accountability towards the use of donor funds and resources will be plausible. To this effect, both NGOs and farmers need to provide documented evidence of the impact of extension services on cocoa production and other outcome variables previously mentioned. Whereas accountability is believed to bring some form of transparency that will ultimately address any possible misuse of resources, the promotion of economic gains and elimination of poverty pervasive among rural cocoa farmers should be the ultimate aim of such policies. Also, agricultural sector policy measures directed at improving the formation of NGOs and engagement of relevant stakeholders such as agricultural extension officers from the Ghana Cocoa Board and the Ministry of Food and Agriculture would greatly improve cocoa production and improvement in farmers' welfare. This study further reiterates that effective policy in the organization of NGOs is very important in improving cocoa yield and the total income of cocoa households. Consequently, this will not only enhance productivity but also lead to an increase in gross domestic product and create a good image for NGOs operating within the cocoa sector.

3.8. Limitations and outlook

Undoubtedly, just like any empirical study, this study has limitations. First, due to resource constraints, this study selected only three out of five districts where the extension program is implemented. Moreover, only 200 participants were selected, accounting less than 10% of the total farmer population actively engaged in the extension service (n=3 500). Second, the study area — the Eastern Region — is the third-largest producer of cocoa beans in Ghana and hence one would have expected that either the country's first or second major cocoa growing region would be selected as study area. This is not a big issue since poverty exists among a great proportion of rural cocoa farmers in the country. Moreover, selecting an NGO extension program carried out concurrently in more than one region will suffice. Third, the unfavorable weather condition made up of serval days of heavy rainfall constrained the data collection process because enumerators must forcibly take several days off. Another major concern was the inaccessibility to the selected households since most farmers reside on their farms in an entirely secluded area with poor road networks, where many data numerators declined to go. Finally, the high illiteracy rate of respondents constrained the data collection process because enumerators needed to read and translate the questionnaires into the native language for farmers to understand.

4. Conclusion

The role played by non-governmental organizations (NGOs) in reducing poverty and hunger by increasing agricultural productivity and household income is commendable particularly in the cocoa sector. However, documented evidence is lacking in such direction especially among smallholder cocoa farmers in Ghana. This study aimed at assessing the effects of the CLP extension service delivery on farm productivity and income of 200 rural cocoa farmers selected from three districts of the Eastern Region. Three methods, regression on covariates, propensity scores, and Heckman's treatment effect model, were used to ensure robust estimates and control for selection bias. The estimated results showed a positive and significant effect of the CLP extension program on cocoa yield and household income. Specifically, after correcting for selection bias, the estimated results showed that the extension program was significant in increasing participating farmers' cocoa yield by 14.3% only in the Heckman's model. The effects on farm income showed a significant increase of 25.1 and 42.9% when estimated with regression on propensity scores and the Heckman's model, respectively. Across all the three models, program participation led to an increase in total household income by 47.2, 32.8, and 74.3%, respectively. However, participation in the extension program was negatively influenced by the age of household head, participation in secondary occupation, and access to credit. Apart from the welfare effect derived from program participation, the influence of other socio-economic, farm, and institutional factors on household income were evaluated. This study reaffirmed that agricultural extension services delivered by NGOs were fundamental in increasing cocoa production and household income. Since the government of Ghana through the Ministry of Food and Agriculture, Ghana Cocoa Board, and the Cocoa Research Institute are thriving to increase national cocoa output, better policies that favor the working conditions of NGOs in the country should be enacted. Conclusively, this study recommend that government and development partners should invest in extension programs throughout cocoa growing regions in Ghana by providing enough logistics, recruiting and training more qualified agents, and creating a conducive atmosphere to support learning and technology adoption.

Acknowledgements

This research was funded by the Academy–Locality Cooperation Project of Chinese Academy of Engineering (2019-JL-1-5).

Declaration of competing interest

The authors declare that they have no conflict of interest.

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