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Empirical Analysis of the Role of Extension Programmes on Adoption of Improved Cocoa Seedlings and Productivity in Ghana

MASTER'S THESIS

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Declaration

I hereby declare that I completed this thesis titled "Empirical Analysis of the Role of Extension Programmes on Adoption of Improved Cocoa Seedlings and Productivity in Ghana" independently and that the text of this thesis is original, and all sources have been fully referenced and acknowledged in accordance with the FTA citation rules.

In Prague 25th April 2024

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Adwoa Benewaa Opoku

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Abstract

The Ghana Cocoa Board has introduced productivity-driven extension programmes such as the free improved hybrid cocoa seedling to boost national cocoa production. Yet not all cocoa farmers in Ghana have enrolled on these extension programmes. This research examines i) the drivers of farmer participation in cocoa extension programmes, ii) the effect of participation on the uptake of improved hybrid seedlings, and iii) the subsequent impact on cocoa productivity. We used multistage sampling, comprising purposive, convenience and simple random samplings, to select 293 extension participants and 193 non-participating smallholder cocoa farmers from 2 districts within Ahafo Ano in the Ashanti Region of Ghana. The thesis adopted logit regression to test our assumptions on the drivers of extension participation and the effect of participation on farmers' adoption or non-adoption of hybrid seedling. We then analysed the impact of adopting a hybrid seedling on cocoa productivity using linear regression.

Our findings indicate that i) large household size, personal farm ownership, accessing off-farm income, membership of farmer groups, increased training on good cocoa management, and proximity from district market to farm increased participation in extension programmes; ii) participation in coco extension increases farmers’ propensity to adopt hybrid cocoa seedling, iii) which in turn raises productivity. Therefore, to increase farmers’ productivity, we recommend extensive spread of information on the free hybrid seedling programme among non-participants of cocoa extension programmes. In particular, the delivery of extension should include non-members of farmer groups and those who do not receive training and are located far from the district market.

Keywords: Cocoa extension programmes, hybrid cocoa seedlings, productivity, regression analysis, Ghana Cocoa Board.

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List of Acronyms

AE	Agricultural Extension
CEPPP	Cocoa Extension Public-Private Partnership
CHED	Cocoa Health and Extension Division
CHP	Cocoa Hand Pollination
COCOBOD	Ghana Cocoa Board
CODAPEC	Cocoa Disease and Pest Control
CRIG	Cocoa Research Institute of Ghana
CSD	Cocoa Services Division
CSSVD	Cocoa Swollen Shoot Virus Diseases
CSSVDCU	Cocoa Swollen Shoot Virus Diseases Control Unit
DTDMC	Distance from Farm to District Market Centre
HI-TECH	Cocoa High Technology
ISSER	Institute of Statistical Social and Economic Research
LBCs	Licenced Buying Companies
MoFA	Ministry of Food and Agriculture, Ghana
NGCMT	Number Of Good Cocoa Management Training
PEPs	Productivity Enhancement Programmes
SPU	Seed Production Unit
SSA	sub-Saharan Africa
T&V	Training and Visit

1. Introduction and Literature Review

1.1. Background and problem statement

Over 80% of the world's cocoa is produced in West African countries (Odijie 2023). Together, Ghana and Côte d'Ivoire contribute 60% of the global cocoa supply (Odijie 2023). Ghana ranks as the second largest cocoa producer globally, following Côte d'Ivoire (Onumah et al. 2013). In the words of Hudson (2022), "Ghana is cocoa and cocoa is Ghana". Historically, cocoa has been a major industry and a vital source of export revenue for Ghana. For example, cocoa accounted for nearly 10% of the nation's GDP in 2021 alone, contributing around GHS3.1 billion (USD 533 million) to the GDP (Ghana Cocoa Board – COCOBOD 2024). According to Hudson (2022), up to 800,000 people are directly employed on cocoa plantations, while the sector supports about 4 million livelihoods, or about 16.5% of Ghana's population of 24.5 million in 2010 (Attipoe et al. 2021).

However, cocoa yields are relatively low in Ghana, ranging between 400 and 530 kg/ha against a potential yield of 1000 kg/ha (Barrientos et al. 2008). A comparison of Ghana with similar cocoa-growing nations like Côte d'Ivoire shows that the country is underperforming (Binam et al. 2008; Bymolt et al. 2018). Production in Ghana is mostly through smallholders, farming on comparatively small land areas, between 0.4 and 3.0 hectares (COCOBOD 2002; Hudson 2022), using conventional agricultural methods and getting meagre productivity (Danso-Abbeam et al. 2012). Cultivating low-yielding cocoa varieties is partially responsible for the reduced yield in the cocoa industry, as per the findings of Dormon et al. (2004).

The Cocoa Rehabilitation and Free Hybrid Seedling Distribution (CRFHSD) programme was initiated by Ghana's Cocoa Health and Extension Division (CHED) under COCOBOD to increase productivity (COCOBOD 2022) in 2001. The aim of this programme is to restore aged and unproductive cocoa farms infected by Cocoa Swollen Shoot Virus Disease (CSSVD), replant burned farms, and establish new farms with disease-tolerant and high-yielding seedlings that mature early (Acheampong et al. 2023). The CRFHSD programme has been lauded by industry players as a key reason why Ghana achieved over 1 million metric tonnes (1,004,194 mt) total production in the 2010/2011 crop season, a year earlier than it had targeted (Essegbey & Ofori-Gyamfi 2012).

The literature shows that participation in extension programmes increases farmers' propensity to adopt improved crop varieties and new farming technologies (Mgendi et al. 2022), such as improved hybrid seedlings. Takahashi et al. (2018) demonstrated how growing improved seedlings raises crop productivity, income and the welfare of smallholders. However, there is limited empirical research examining the impact of yield-driven extension programmes on cocoa productivity in Ghana. Previous studies have primarily concentrated on non-governmental extension efforts (Attipoe et al. 2021). This research extends the scope of the existing research by examining the impact of extension programmes (both governmental and non-governmental) on farmers' adoption of Ghana's free hybrid seedlings.

Asfaw et al. (2012) argued that the uptake of farming innovations by smallholders in remote areas will increase yields and ultimately reduce poverty. Agricultural extension, as Bonye et al. (2012) and Feder et al. (2004) argue, serves as a tool for introducing modern technologies to large groups of farmers, eventually improving productivity and incomes. Effective extension programmes are therefore recognised as a gateway to cocoa and agricultural development (Binam et al. 2008). The low yields of Ghanaian cocoa farms amid the growing world demand for cocoa beans (Odijie 2023) make it necessary for the country to use extension programmes such as free hybrid seedlings as a tool to drive productivity and assist farmers financially. But not all cocoa farmers in Ghana participate in productivity driven extension programmes such as the free hybrid seedlings due to programme inefficiencies and other factors (Tham-Agyekum et al. 2022).

This research uses data collected from 293 beneficiaries of the COCOBOD (i.e., government) and NGO-led extension programmes and 123 non-beneficiaries from the Ahafo Ano Southwest and Southeast Districts of Ghana to respond to these questions: i) What are the drivers of farmer participation in extension programmes? ii) Does participation in cocoa extension programmes affect farmers' uptake of a hybrid cocoa seedling? iii) What are the effects of adopting an improved hybrid seedling on cocoa productivity?

The research informs the Government of Ghana and COCOBOD of further productivity-driven policy initiatives aimed at achieving the potential cocoa yield levels. It also guides development agencies supporting farmers in sustainable cocoa production in the targeted areas. It can help inform farmers about the benefits of cocoa extension programmes and hybrid seedlings adoption. The thesis adds to the empirical literature on the influence of extension on farmers' use of hybrid cocoa seedlings and their impact on cocoa productivity.

1.2. Literature review

1.2.1. Agricultural extension – a brief overview

Agricultural extension is an informal educational system that provides advisory and information services to help rural people solve their challenges. It also aims to increase farmer efficiency, boost output and enhance the overall economic well-being of farm households (Food and Agricultural Organization of UN – FAO 2019). Extension aims to provide new viewpoints and knowledge to rural regions to enhance the living conditions of smallholders and their families. Hence, farmers must receive this necessary assistance to enhance farming and other livelihood services. According to FAO (2019), the relevance of extension can be summarised in three components: Knowledge<->Communication<->Farm Family.

Agricultural extension theories have shifted over time, resulting in the evolution of agricultural development paradigms giving rise to different extension methodologies (Taye 2013). According to Taye (2013), earlier models that emphasised technology transfer through 'top-down', 'linear' and rigorous methods have been criticised for their limited vision and for treating farms as ineffective beneficiaries. The models also failed to consider the more comprehensive socio-economic and institutional variables that may affect farmers (Taye 2013). The objective of today's agricultural extension is not limited to merely disseminating information and technology. Danso-Abbeam et al. (2018) contended that extension involves making advanced technologies accessible to farmers, enhancing their knowledge and skills, and improving their overall quality of life.

Extension programmes are crucial in promoting rural areas' overall growth and welfare (Danso-Abbeam et al. 2018). It helps in achieving rural development policy objectives and a strategy for promoting sustainable agriculture. Its primary function is to facilitate communication and behaviour change among rural populations, often by influencing local ideas (Bonye et al. 2012). In many countries in Africa, extension services are a crucial part of the agricultural production chain. The government, NGOs, and the private sector provide them. However, the public agricultural extension sector faces several challenges, such as inadequate funding and limited policy focus. As a result, various agricultural development initiatives are exploring alternative private extension and advisory service models (Ugochukwu et al. 2021).

1.2.2. History of cocoa extension in Ghana

Over time, many adjustments have been made to Ghana's agricultural extension (AE) (Ekepi 2009). Ekepi asserts that the founding of AE in Ghana was motivated by earlier missionary and expatriate companies engaged in the export of cocoa, rubber and coffee in the nineteenth century. Since then, Ghana has embraced a few extension strategies, including donor-funded extension initiatives like USAID's Focus and Concentrate in the 1960s, cooperative movements, and state-funded extension (Ministry of Food and Agriculture Ghana - MoFA 2002). Prior to the 2000s, Ghana's cocoa extension was managed by COCOBOD's Cocoa Services Division (CSD) (MoFA 2002). The main responsibility of the CSD was to offer recommendations for enhancing cocoa farming. The CSD adapted the training and visit method to include strategies like rallies, demonstrations, personal interactions with farmers and input provision. However, the input supply function was eventually abandoned because of market liberalisation (MASDAR 1998; Aneani et al. 2011). In addition, the CSD employed additional extension strategies, including participatory technology development and extensions, market-oriented agriculture programmes and farmer field schools (MoFA 2002). The CSD's extension services were specifically designed for the cocoa industry, with an emphasis on providing farmers with technical advice and knowledge transfer (MoFA 2002).

However, to provide a cost-effective extension programme and lower COCOBOD expenses, cocoa extension was combined with all other extension services offered by the other MoFA divisions (Baah & Anchirinah 2010). According to a report by MASDAR (1998), the CSD section of COCOBOD employed the greatest number of people (3,375), and its expenses made up roughly 2.7% of the FOB (freight on board) price of cocoa. A merger with other MoFA extension divisions may save the government almost 20 billion cedis yearly, according to a MASDAR (1998) report, which noted that the cost of one extension worker per farmer was approximately USD 6,143 annually (Baah et al. 2009). Years after the merger, however, it became clear that a cost-benefit study had not been carried out before the decision was made. First, the MoFA was unprepared for the extension of cocoa before the merger. Consequently, MoFA worked alongside the Cocoa

Research Institute of Ghana (CRIG) to train the personnels of MoFA. These two companies' differing use of extension models posed a significant challenge. For instance, the MoFA extension is modelled so that one Extension Agent (EA) collaborates with farmers who are growing various crops. Third, there were fewer EAs at MoFA. Fiadjoe (1999) states that the extension-to-farmer ratio decreased to 1:1500 under the MoFA from 1:127 under the CSD. Finally, due to resource disparities, MoFA was unable to offer cocoa farmers the same level of extension contacts and advice as it had under the CSD. For example, in 2001, MoFA received just 20% of the authorised operational spending (Mezah & Mensah 2002). It was anticipated that during the merger, the cocoa sales levy that supported the CSD would be moved to the MoFA extension services section, but that did not occur (Baah & Anchirinah 2011). For these reasons, cocoa farmers often complain about and are dissatisfied with the quality of government extension services (Mezah & Mensah 2002).

A committee was formed by COCOBOD to devise the terms of a new cocoa extension for Ghana in response to the backlash and grievances raised by cocoa producers as well as various interested parties (Baah & Anchirinah 2011). Extension for cocoa producers was to be formed under the Cocoa Swollen Shoot Virus Diseases Control Unit (CSSVDCU). The cocoa extension was established by CSSVDCU in 2010 using a public-private partnership model (E-Agriculture 2017). The roles of the CSSVDCU included preventing the infection of plantations by CSSVD and other diseases, assisting farmers in the replanting of improved cocoa varieties, supporting the development of new cocoa varieties in treated and rehabilitated fields, and providing backup extension services to Ghanaian cocoa producers (E-Agriculture 2017). Figure 1 illustrates the existing structure of Ghana’s cocoa extension.

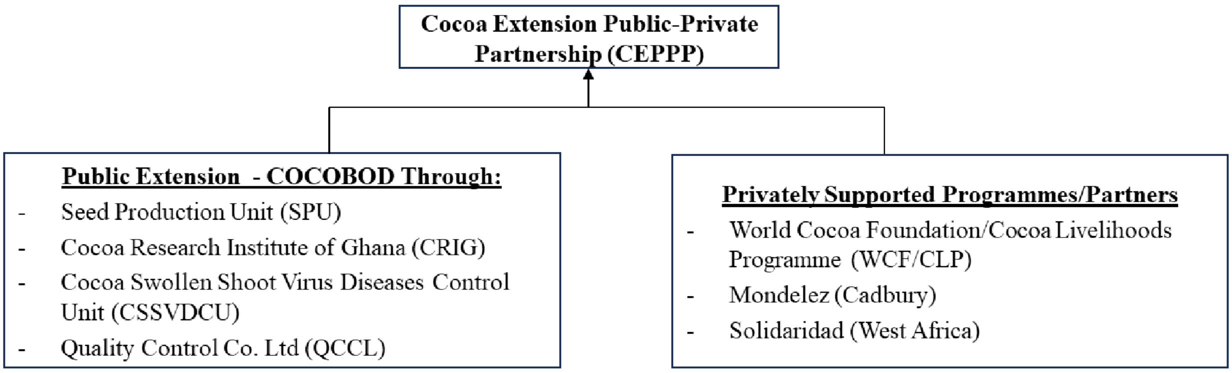

Figure 1: Existing structure of cocoa extension in Ghana

The Cocoa Extension Public-Private Partnership (CEPPP) initiative was launched with a small team of highly skilled and prepared experts who are committed to providing affordable and effective technical advisory services to cocoa farmers who are ready for business-oriented support and willing to take ownership of the extension process (E-Agriculture 2017). Ghana COCOBOD and its subsidiaries, including the Seed Production Unit (SPU), CRIG, CSSVDCU and Quality Control Co. Ltd (QCCL), are responsible for the CEPPP. The World Cocoa Foundation/Cocoa Livelihoods Programme (WCF/CLP), Mondelez (Cadbury), Solidaridad (West Africa) and farmers are among the other allies and business partners (E-Agriculture 2017; Bymolt et al. 2018). The private partners provide the funding to hire, pay and train the extension agents. They also provide the tools and materials needed to train cocoa farmers (E-Agriculture 2017).

1.2.3. Cocoa rehabilitation/Free hybrid seedling distribution programme

Due to the Cocoa Swollen Shoot Virus Disease (CSSVD), Ghana's annual cocoa production drastically decreased after reaching a milestone of above 1 million mt during the crop season of 2010–2011. For example, out of 1.9 million hectares (ha) of cocoa farms in Ghana, 315,886 ha were lost in 2020 because of the CSSVD, accounting for 16.6% of all Ghanaian cocoa farms (COCOBOD 2020). Several cocoa plants in Ghana were also over fifty years prior to 2012, which contributed to the decline in productivity (Laven & Boomsma 2012). To give cocoa farmers better seeds, the Ghanaian government launched the Cocoa Rehabilitation Programme (CRP) in 1984 under the Seed Production Division of COCOBOD.

In the 1980s and '90s, the goal was to give farmers high-yielding cocoa pods (the pods hold the seeds) for GHS 0.20 (USD 0.015, 2024 exchange rate) each for the purpose of nurturing and later transplanting. This strategy, however, was unsuccessful for several reasons. First, rather than raising the seeds, some farmers added the cocoa beans intended for sowing to their bean inventories for direct sale since it was a cost-effective option. Second, a few farmers also didn't give their seedlings any attention before planting them straight (COCOBOD 2018). In the early 2000s, the CRP was evaluated in response to the removal of old, disease-infested cocoa plants infected with CSSVD and their replacement with already-nursed, early-maturing, high-yielding hybrid cocoa seedlings that were disease-tolerant (AsokoInsight 2021). In an effort to replace 20% of cocoa trees over 50 years old, the CRP delivered 20 million hybrid seedlings in 2012 (Kolavalli and Vigneri 2018). To increase output and farm revenue, COCOBOD, via the Seed Production Division, produces enhanced cocoa seedlings and provides them to farmers annually between May and July (Attipoe et al. 2021). The seedling distribution was the responsibility of the Cocoa Health and Extension Division – CHED (COCOBOD 2022).

Other productivity-driven extension programmes promoted by COCOBOD in Ghana

a) *Cocoa swollen shoot viral disease* (CSSVD) *and Cocoa high technology programmes*

Since the 1930s, when the CSSVD first appeared, Ghanaian cocoa farmers have benefited from creative extension efforts (Ameyaw et al. 2014). Over the years, various strategies and policies have been developed to boost productivity while managing diseases and pests. For example, the Cocoa Research Institute of Ghana (CRIG) introduced the Cocoa High Technology

(HI-TECH) initiative in 2001 to counteract the reduction in cocoa production by raising the productivity of already-existing cocoa plants without expanding the total planted area (Appiah 2004). Together with tackling other subpar agronomic practices such as neglecting cocoa farms, failing to maintain culture, and diminishing soil fertility, the programme was jointly managed by CRIG and MoFA with the goal of boosting cocoa yield through the control of cocoa pests and diseases (Appiah 2004). The HI-TECH programme consisted of two parts: 1) upkeep of cocoa plantations using good agronomic procedures, such as general pruning, *mistletoe* and *choppon* pruning, and twice or three times a year of weeding; 2) fertiliser application following farm maintenance – For every 0.4 ha of cocoa plantation, 150 kg of recommended fertiliser should be applied (Owusu-Achaw 2012). Furthermore, to run alongside the Cocoa HI-TECH, the Cocoa Disease and Pest Control (CODAPEC) programme was started in 2001. Farmers in Ghana refer to this programme as the Cocoa Mass Spraying Exercise. In addition to teaching farmers about cocoa pests and disease management, the proposal called for government-appointed extension agents to spray all cocoa farms impacted by capsid and black pod disease extensively and for free (COCOBOD 2011).

Through the implementation of the Cocoa HI-TECH and CODAPEC programmes, the government aimed to raise cocoa production to one million metric tonnes (mt) by the 2012–13 crop season. However, because of the CODAPEC programme's efficacy, this goal was accomplished a year ahead of schedule (1,004,194 mt in 2010/2011) (Essegbey & Ofori-Gyamfi 2012). The agricultural sector of Ghana grew by 5.25 percent on average between 2001 and 2012 thanks to these fruitful efforts, which had a big effect on the nation’s economic performance (Institute of Statistical Social and Economic Research - ISSER 2013).

b) *Cocoa hand pollination and mass pruning programmes*

Due to the constraints posed by climate change, Ghana's cocoa pollination rates have historically been low, yet research indicates that raising pollination rates can boost output (Tham-Agyekum et al. 2022). Adjaloo (2012) observed that hand pollination enhances the development of cocoa fruits, the total quantity of developed pods, and the quantity of beans in a pod. Farmers are trained in artificial hand pollination by the Ghanaian Cocoa Research Institute (CRIG) through the CHED (COCOBOD 2018). A method called Cocoa Hand Pollination (CHP) was implemented by COCOBOD in 20217 as a part of the Productivity Enhancement Programmes (PEPs) with the goal of increasing smallholder cocoa farmers' yield to more than 1000 kg/ha. As a result, the CHP contributes to increased pollination, a bountiful harvest, increased cocoa bean exports from Ghana, and higher income levels for communities that grow cocoa (COCOBOD 2018). In areas of the tree where development is uneven or insufficient, hand pollination is carried out to supplement natural pollination to maximise pod formation. By increasing the number of pods produced by natural cocoa pollination, which typically results in 20 to 50 pods per tree per cocoa growing season, the method overcomes this constraint (COCOBOD 2018).

The cocoa mass pruning programme is also one of the PEPs launched in the 2018/2019 cocoa growing season by COCOBOD to remove excess branches, infested and dead branches from the cocoa trees before the flowering season to ensure increased flower development (COCOBOD 2020). The appropriate time to perform pruning is in February to achieve the maximum benefit of improved crop yield, disease prevention, increased cocoa bean quality and increased tree lifespan, which intends to improve cocoa farmers' livelihoods (COCOBOD 2020)

1.2.4. Determinants of farmer participation in extension programmes

Participating in extension programmes depends on several factors, including farm, farmer and household, socioeconomic, and institutional variables (Abdul-Rahaman & Abdul-Hanan

2016). Education level, farm size and accumulation of wealth – such as the number of livestock – are important variables that positively influence farmers' participation in extension programmes, according to Ragasa et al. (2013). Nnadi and Akwiwu (2008) argued that smallholders with high education might be receptive to the latest ideas and technologies and have a high propensity to participate in extension initiatives. Research shows that the decision of a farmer to take part in extension programmes might be influenced by their gender, either positively or negatively (Nnadi & Akwiwu 2008; Nxumalo & Oladele 2013). Due to their propensity for greater social interaction, female farmers might be more inclined to be involved in agricultural projects. However, men in Africa typically have greater access to and authority over resources (Etwire et al. 2013). Since male farmers are the ones who usually make the decisions, they have a high propensity to participate in extension programmes (Nxumalo & Oladele 2013). Nnadi and Akwiwu (2008), however, could not discover any connection between farmers' involvement in an agricultural initiative and gender. Additionally, farmers with large-scale and resource-rich farmers may be resourceful and have greater flexibility in investing in emerging innovations, which can increase their likelihood of participating in extension programmes.

However, other studies argue that age may negatively affect access to different forms of extension services (Abdul-Rahaman & Abdul-Hanan 2016). Older farmers may face challenges in adopting modern technologies due to limited mobility, resistance to change, or a lack of familiarity with modern agricultural practices. This can hinder their access to extension services, often delivered through modern means such as internet-based platforms or mobile applications. According to Etwire et al. (2013), young farmers are highly inclined to join farming projects because they are typically more risk-takers, inventive, and willing to try out novel ideas. Alternatively, some studies have observed a direct correlation between age and smallholders' decision to join agricultural initiatives (Nxumalo & Oladele 2013; Farid et al. 2009). According to

Etwire et al. (2013), smallholders with sizable households can easily designate key household tasks to some family members while working on a project and vice versa. The authors contended that joining extension initiatives increases with the size of the household since each matured member of the family is capable of being a conduit of knowledge or a benefactor of an agricultural initiative.

Institutional variables, like availability and ease of accessing extension programmes, can also have a significant influence on farmers' ability to participate in extension programmes (Nahayo et al. 2017). The presence of extension programmes in rural areas, the availability of trained extension agents, and outreach efforts to reach marginalised or remote communities can affect farmers' accessibility to extension initiatives. Other factors, including income level, social networks, and community dynamics, can also influence farmers' accessibility to extension programmes. Smallholders with credit accessibility, higher incomes and more extensive social networks may have more resources and opportunities to access extension services (Nahayo et al. 2017). In contrast, those with limited financial means and social connections may face barriers to obtaining such services. However, no significant relationship was observed between taking part in agricultural extension activities and having access to credit (Oladejo et al. 2011).

1.2.5. Factors influencing cocoa productivity

Effendy et al. (2019) shed light on the various factors that influence cocoa productivity and efficiency. The study found that the frequency of extension services and farmer training, access to quality seeds, credit availability from banks, use of organic fertilisers, market access, women's participation, and the gender of the farmer all play significant roles in cocoa production. Effendy et al. (2019) emphasised that these factors positively impact cocoa productivity in Indonesia, as they contribute to a significant increase in cocoa output. However, the study also highlighted that most cocoa farmers face inefficiencies in managing their cocoa farms. These inefficiencies are attributed to deficiencies in the abovementioned factors, indicating that cocoa farmers face challenges accessing extension services, quality seeds, credit, and markets and struggle with gender-associated problems and women's participation in cocoa production. To address these inefficiencies, the authors suggest the adoption of innovative technologies recommended by extension experts. These technologies have the capability to reduce the problems encountered by cocoa producers and improve cocoa production efficiency. By leveraging modern agricultural technologies and practices, cocoa farmers can overcome limitations related to knowledge, resources, and gender biases, leading to improved cocoa productivity and efficiency.

Massaquoi et al. (2022) showed that multiple factors, including farm size, utilization of fungicides and fertilisers, and household size, exerted a notable and beneficial influence on cocoa productivity and efficiency within the Kailahun District of Eastern Sierra Leone. These factors increase cocoa yield, indicating their importance in cocoa production. The study pointed out, though, that many farmers in the area manage their farm resources inefficiently, which results in the over- or under-utilisation of certain factors of production. Beyond the examination of farm-level variables, it is imperative to evaluate the contribution of cooperatives in shaping cocoa productivity and efficiency.

Kehinde and Ogundeji (2022) compared farmers who were members of cooperatives with non-members and found that cooperative membership had significant benefits. Smallholders who participate in cooperatives have improved access to resources such as fertilisers, insecticides, extension training, and bank credit than non-members. This improved resource access enables cooperative members to increase efficiency and productivity. The study concluded that cooperative membership and participation positively impacted farmers' efficiency and productivity. Being part of a cooperative also provides farmers access to knowledge, enhancing their ability to manage their farms effectively.

1.2.6. Effect of extension on farmers' uptake of new plant varieties and agricultural technologies

The effect of extension programmes has been the subject of mixed outcomes in research (Davis 2012; Kalimuthu et al. 2018; Nakano et al. 2018). Research conducted in Uganda, for example, revealed that the adoption rate of enhanced seeds remained statistically unchanged during training session lobbying (Anderson & Feder 2007; Davis 2012). However, according to studies, in Tanzania, farmers who participated in extension programmes increased the rate or intensity of improved technology uptake (Nakano et al. 2018; Mgendi et al. 2022). Nakano et al. (2018) showed, in their study on Tanzania's Ilonga irrigation network, that the farmer-to-farmer training programme raised farmer use of fertiliser by 52% and their row transplanting by 49%–81%. Disease tolerance, pests, and drought-improved plant varieties can be employed to increase farm revenues and farmer livelihoods, claim Kostandini et al. (2013). Salem (2011) found that enhanced crop types are more likely to be adopted when agricultural extension is used. Yamano et al. (2018) assert that agricultural extension is essential in informing smallholders about the advantages of growing resilient plant varieties.

When extension programmes are made available, farmers use technology more frequently (Udimal 2017). Extension personnel educate farmers about the benefits of new technologies. Extension personnel serve as mediators between innovation users and researchers or inventors (Udimal 2017). This lowers the transaction costs associated with educating a sizable and diverse group of farmers about the new technology (Genius et al. 2013). Extension agents can directly or indirectly affect the entire number of farmers in the areas they serve. They usually work with individual farmers or farmers that a single farmer interacts with (Genius et al. 2013). Literature has shown a direct association between extension programmes and technology acceptance. One such study is the use of imazapyr-tolerant innovation in maize cultivation by Mignouna et al. (2011). The use of enhanced agricultural techniques by Ghanaian farmers (Akudugu et al. 2012); the uptake of improved land management and maize in Uganda (Sserunkuuma 2005); and factors influencing the acceptance of technology among Nepalese people are just a few examples. This is due to the expectation that information exposure will encourage adoption among farmers, as per the innovation diffusion theory (Uaiene 2011). Extension agents' influence can mitigate the adverse consequences of the absence of regular schooling in the choice to adopt specific technologies in general, as Yaron et al. (1992) pointed out.

1.2.7. Effect of extension programmes and improved crop varieties on agricultural productivity

Empirical studies on the impact of extension programmes on productivity present mixed conclusions. Indeed, Betz (2009) notes that several research on the impact of extension services on yields show positive effects. Research by Danso-Abbeam et al. (2018) shows that extension initiatives improve crop productivity and household farm income in northern Ghana. Similarly, Bonye et al. (2012) argue that extension gives farming communities access to information about new technology that can raise output, incomes, and living standards if adopted. Alemu et al. (2016) explained that extension agents manage change, educate farm households about new technologies, act as catalysts to promote acceptance, and try to block specific individuals from halting the channel of diffusion. Thus, agricultural extension agents serve as drivers of technology diffusion, which has a consequential impact on agricultural productivity.

In the cocoa sector, research by Taku et al. (2020) contended that farmers who enroll in extension programmes could determine how technologies promoted under the programme fit into the overall cocoa production process and how it contributes to their source of income. Extension programme facilitates the use and adaptation of technology in rural communities, thereby bridging the gap between farmers and scientists. Farmers get the most recent research findings through extension programmes and are assisted in addressing the obstacles and constraints they encounter in putting these methods into practice (Anderson & Feder 2004). Extension agents employ various methods, such as radio and television broadcasts, printed materials, and general gatherings, to raise awareness among cocoa farmers (Taku et al. 2020). The authors further show that smallholders in the cocoa industry adopt modern technologies such as improved seedlings, mass sprayers, fermentation stations, and solar dryers through extension contacts. Extension agents also conduct demonstrations as needed to facilitate the effective implementation of these advancements in cocoa production (Taku et al. 2020). Danso-Abbeam et al. (2018) argued that extension often prioritises early technology adopters, who can then serve as agents to disseminate information to laggards. This strategy aims to recognise and address farmers' challenges while providing policy direction in the agricultural industry. Previous studies (Geer et al. 2006; Davis et al. 2012) have shown the beneficial impacts of extension initiatives on agricultural yields.

In summary, agricultural extension promotes adopting new technologies, which boosts productivity and, in turn, promotes socioeconomic growth (Kariyasa & Dewi 2013). According to Chen and Ravallion (2004), the main reason Asian countries have had such success with the green revolution is the adoption of new technologies, such as improved crop varieties. In their summary of an earlier study on the effects of adopting agricultural innovation adoption on smallholders, Takahashi et al. (2018) demonstrated how growing new crop varieties is positively influenced by extension programmes, which in turn improves yield, household income, consumption, and the welfare of farmers.

2. Aims of the Thesis

2.1. Research objectives

This research aims to analyse the factors affecting farmer participation in cocoa extension, the effect of participation on the adoption of improved hybrid cocoa seedlings and the subsequent impact on cocoa productivity in Ghana. Specifically, our study seeks to:

- examine the factors influencing farmers' decisions to participate in cocoa extension programmes,
- analyse the impact of participation in cocoa extension on the adoption of improved hybrid cocoa seedlings by smallholders and
- determine the impact of adopting a hybrid cocoa seedling on cocoa productivity in Ghana.

2.2. Research questions and hypotheses

2.2.1. Research questions

- What factors affect a farmer’s willingness to participate in a cocoa extension programme?
- Does participating in cocoa extension affect farmers' adoption of improved hybrid cocoa seedlings?
- What is the relationship between hybrid cocoa seedlings adoption and cocoa productivity in Ghana?

2.2.2. Research hypotheses

- **H1:** Participating in cocoa extension programmes positively influences a farmer's decision to adopt improved hybrid cocoa seedlings.
- **H2:** Adopting improved hybrid cocoa seedlings increases farmer productivity.

3. Methodology

3.1. Study area

The research was conducted in the Ahafo Ano Southeast and Southwest Districts in Ghana's Ashanti Region (see Figure 2).

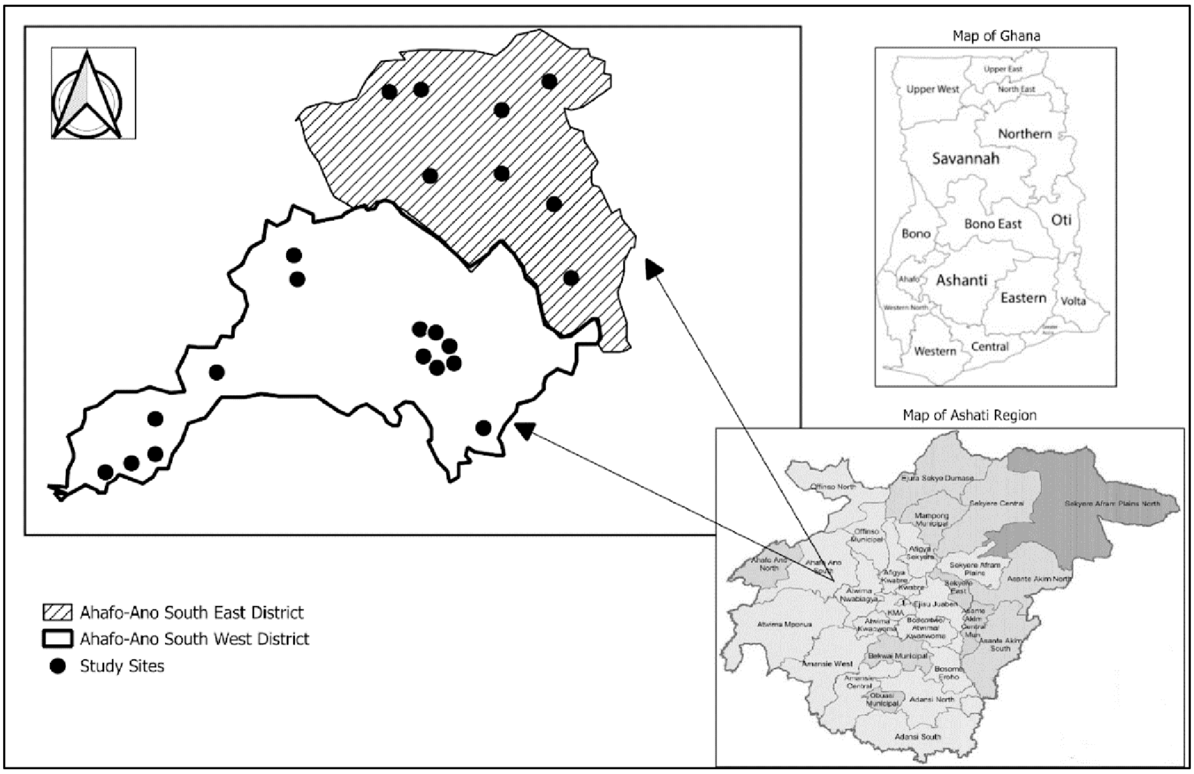

Figure 2: Map of the study area.

Source: Donkor et al. (2023)

The bigger Ahafo Ano South District once included both districts. The districts cover about 1241 km², making up 5.8% of the entire region (Ghana Forestry Commission 2022). These districts are located in Ghana's forested region. The districts have a lot of arable areas with vegetation and a climate that is ideal for growing food. Because of its depth, the soil can support a wide variety of food crops, including vegetables, tuber crops, cereals, legumes, plantains and sugarcane, as well as cash crops, including cocoa, palm trees, and coffee (Ghana Forestry Commission 2022). As a result, according to the Ghana Forestry Commission (2022), farming is the third-biggest means of employment in the Ashanti region (36.6%) and the biggest employer in the research area (74.9%).

Majority of the active labour force (53%) is involved in cocoa farming (Ghana Forestry Commission 2022). Most of the communities within the districts are rural, making extension services essential for disseminating important technologies and information to the smallholders. Conversely, the existing ratio (1:700) of extension agent-to-farmer in the country by 2020 (MoFA 2022) is making it challenging for extension agents to provide the above basic services to rural cocoa farmers. COCOBOD and some NGOs, therefore, actively support cocoa farmers in the area through various extension programmes due to the poor extension-to-farmer ratio. To give farmers better extension services, training and workshops are thus organised in groups through producer groups or farmer-based organisations. The free hybrid cocoa seedling distribution, cocoa rehabilitation programme, CODAPEC, artificial hand pollination, mass cocoa pruning, etc., are a few of the significant initiatives that have been put into place thus far in the districts to increase cocoa yields (Donkor et al. 2023). For these reasons, the area is suitable for our research, which seeks to determine the effect of extension programmes on farmers' adoption of improved cocoa seedlings and the subsequent impact on their cocoa productivity.

3.2. Sampling technique

The data used in this thesis is a component of a larger investigation that looked at how farmer group membership affected yield and production efficiency. Consequently, our target population for the research are peasant producers of cocoa who are either members or not of producer organisations. We gathered the data through a multi-stage sampling procedure. Initially, the district cocoa cooperative officers provided a record of cocoa producer associations in the two sampled districts. This list included beneficiaries and non-beneficiaries of government and NGO-sponsored extension programmes. Purposive sampling was used to choose a total of 22 communities among the two districts in question, considering the existence of cooperatives within the communities.

Ten members were randomly sampled in each farmer cooperative in the compiled list that included all members, making an overall sample of 217. We used convenience and purposive sampling to select our respondents in the sampled villages depending on their willingness to participate at the time of the survey, as we lacked a list of non-members. We identified non-members with the support of extension agents and the staff of Licensed (cocoa) Buying Companies (LBCs) within the villages. Further, a total of 199 non-members were interviewed, making the total sample size 416 farmers, including 293 beneficiaries of government and NGO-funded extension programmes and 123 non-beneficiaries of any extension programme. Of the 293 beneficiaries of extension programmes, 183 were members of farmer cooperatives and 110 were non-members. Of the 123 non-beneficiaries, 56 were members of farmer cooperatives and 67 were non-members. The data's composition thus demonstrates that the data is fairly balanced in terms of farmer cooperative members who are participants in cocoa extension and vice versa. The sampled non-members of cooperatives are similarly affected.

In the targeted cocoa district, there are approximately 18,688 cocoa producers, according to information from COCOBOD's CHED. The district director of the MoFA in the area verified this data. Therefore, we calculated the sample size using the established population sample size calculation.

$$\frac{(z^2 * \rho * (1-\rho)/e^2)}{\left(1+\left(z^2 * \rho * \frac{(1-\rho)}{e^2} * N\right)\right)}$$

With a population (N) of 18,688 cocoa farmers, a sample percentage stated as a decimal (ρ) of 0.5, a 6% margin of error (e), a normally distributed critical value at a confidence interval of 95% (z = 1.96), then overall sample size would be 377. However, we slightly increased the sample size to 416 respondents, i.e., 293 extension beneficiaries and 123 non-beneficiaries, to provide for potential non-responses.

3.3. Data collection method

We conducted the survey in September 2021. For the 2020 cropping season, we collected data on the farms, households, institutional features, and overall cocoa production of the farmers. We compared the information on cocoa output collected from farmers with the files maintained by the officials of the Licenced Buying Companies (LBCs) in the communities to guarantee data accuracy. The LBCs keep a record of each farmer's name and the quantity (kg) of cocoa beans they sell during each cropping season. In addition to collecting data through questionnaires, we conducted key informant interviews with COCOBOD district officers to gain an understanding of the cocoa extension support provided to farmers in terms of training on sustainable farming technologies such as the use of hybrid seedlings, pruning, application of fertilisers, hand pollination, pest and fungus control, etc. We also interviewed the LBC officials in the communities to find out how productive the farms were.

3.4. Conceptual framework

Technology adoption is the process of communicating innovation amongst the constituents of a 'social system' through selected channels (Rogers 2003), which starts with awareness creation. Extension programmes are a key channel of technology diffusion that provides direct interaction and precise, timely and relevant information to farmers (Nakano et al. 2018; Xu et al. 2022). Extension programmes aim to improve smallholders' expertise and skills and to promote and develop enhanced technologies. It is a well-known fact that extension is crucial to the growth of agriculture and can enhance the well-being of farmers and rural residents. The literature has indicated that the number of extension contacts has a major effect on the adoption of new crop types (Tomoki et al. 2023) and agricultural technologies (Ali & Rahut 2013; Gao et al. 2020). Through advice and information dissemination, extension reduces uncertainty about the benefits and risks of innovations and can motivate farmers to adopt new crop varieties. The adopted technologies, together with the acquired knowledge and technical advice, improve farmers' productivity. Productivity gains are feasible when there is a discrepancy between actual and prospective productivity (Anderson & Feder 2003). The authors contend that the management and technological gaps are the two "gaps" responsible for the productivity discrepancy. Extension can help close the production gap by speeding up the transfer of technology, enhancing farmers' knowledge, and helping them implement better farming methods (Feder et al. 2004).

Figure 3 demonstrates the synergies between participating in cocoa extension programmes, adopting improved hybrid seedlings and cocoa productivity in Ghana. Cocoa extension programmes in Ghana (public and private) support farmers to adopt improved hybrid seedlings, which is key to increasing cocoa productivity. In addition to technical advice, cocoa extension programmes strengthen farmers' financial capacity by providing credit services through COCOBOD, microfinance and cooperatives (e.g. cash or in-kind loans). This encourages farmers to embrace new technologies that will eventually satisfy their local production demands. By raising awareness, acquiring knowledge and skills through information diffusion, and offering training, cocoa extension programmes facilitate the use of sustainable technologies like improved cocoa seedlings and eventually contribute to higher yields.

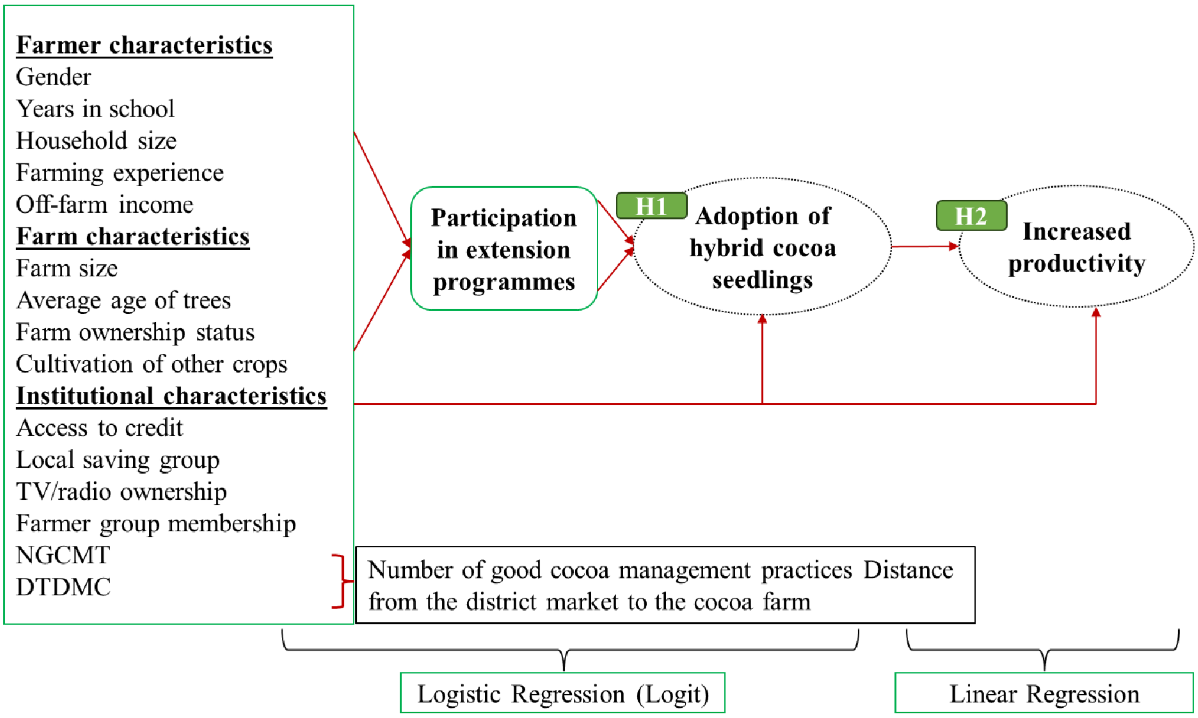

Figure 3: Conceptual illustration of the synergies between cocoa extension, improved hybrid cocoa seedling and productivity

Our research, therefore, assumes that the decision to participate in cocoa extension programmes is affected by several factors, including farmer, farm, and institutional characteristics. Participation in cocoa extension programmes can influence farmers' adoption of improved hybrid seedlings and consequently raise their productivity. The thesis analyses the determinants of extension participation by farmers and the influence of participation on their adoption of hybrid cocoa seedlings using logistic regression (logit). We then determine the impact of adopting hybrid seedlings on farmers' cocoa productivity using a linear regression. The analytical methods are described in detail in the next subsection.

3.5. Analytical framework

We adopt a simple analytical framework to answer the research questions and test our hypotheses. First, we analyse the factors influencing farmer participation in cocoa extension programmes using a logistic regression method. Then, we use extension participation as an independent variable in the next stage to determine its effect on the adoption of improved hybrid seedlings with a logit. Finally, we include adoption of improved hybrid seedlings as an explanatory variable in a linear regression to examine its impact on productivity. Below is a description of our analytical methods.

3.5.1. Logistic regression (logit) model

The research used the logit method to determine what influences farmers' decision to participate or otherwise in cocoa extension and the impact of participating in cocoa extension on adopting improved hybrid seedlings. The logit model was used because the decision to enroll in an extension programme and adopt a hybrid seedling was measured as a dichotomous choice – participate or not participate and adopt or not adopt. We estimate and present the average marginal effects as described by Klieštik et al. (2015) in the result section. Our logit model is given as:

$$E_i = \ln\left(\frac{\rho_i}{1-\rho_i}\right) = \beta_0 + \beta_1 F_i + \beta_2 S_i + \beta_3 C_i + \varepsilon_i, \qquad i = 1, 2, 3, \ldots, N \qquad (1)$$

where E_i represents $\ln\left(\frac{\rho_i}{1-\rho_i}\right)$, ρ_i is the probability of the ith farmer participating in a cocoa extension programme; F_i, S_i and C_i are vectors of farmer, farm, and institutional factors, respectively, captured in the model as controls. β_1,…., β_3 are the calculated parameter coefficients; ε_i is the random error term, β_0 is the constant.

We capture the dependent variable of eq (1) as an explanatory variable in eq (2). Below is the model.

$$H_i = \ln\left(\frac{\rho_i}{1-\rho_i}\right) = \beta_0 + \beta_1 E + \beta_2 F_i + \beta_3 S_i + \beta_4 C_i + \mu_i, \qquad i = 1, 2, 3, \ldots, N \qquad (2)$$

where H_i denotes $\ln\left(\frac{\rho_i}{1-\rho_i}\right)$, ρ_i is the probability of the ith farmer adopting hybrid seedlings; E represents farmer participation in an extension programme (i.e., and independent variable in equation 2); μ_i is the random error term.

3.5.2. Linear regression model

Since cocoa productivity was measured as a continuous variable, we used linear regression to analyse the effect of adopting improved hybrid seedlings on cocoa productivity. Thus, we capture the dependent variable of eq (2) as an explanatory variable of interest in our third equation. Below is a description of the linear regression model for this research.

$$Y_i = \beta_0 + \beta_1 H + \beta_2 F_i + \beta_3 S_i + \beta_4 C_i + \varepsilon_i, \qquad i = 1, 2, 3, \ldots, N \qquad (3)$$

where Y_i is the cocoa productivity or average cocoa beans produced ith farmer per ha in a year in kg (i.e., dependent variable). H represents adoption of hybrid seedlings; F_i, S_i and C_i are vectors of farm and farmer and institutional factors used in our model as controls. β_0 is the constant, whereas β_1,……, β_4 the calculated coefficient parameters, while the random error term is denoted by ε_i.

3.6. Variable definition and description

3.6.1. Treatment variable

Our treatment variable for this research is participation in cocoa extension. Participation in cocoa extension is a dummy variable, where 1 means the farmer participated in any cocoa extension programme (private or publicly funded) within the last two cocoa growing seasons and 0 = if a farmer did not participate in any cocoa extension within the last two cocoa growing seasons. The treatment variable was used as the dependent variable for our first binary logit, which was used to determine the drivers of cocoa extension participation. Of the 416 sampled farmers, 293 (70%) farmers participated in cocoa extension programmes, while 123 (30%) farmers did not participate in cocoa extension programmes. The relatively low non-participating respondents can be ascribed to the number of private and public cocoa extension in Ghana due to the importance of cocoa as the second export earner after oil. Various support and free extension programmes are designed to support the cocoa sector, and farmers are encouraged to participate.

3.6.2. Dependent variables

As shown in our conceptual framework, adopting hybrid seedlings and cocoa productivity are our dependent variables for this study. Adoption of hybrid seedlings is a dummy variable, where 1 indicates that the farmer uses hybrid seedlings prescribed by COCOBOD (i.e., seedling has short maturity, is diseases-resistant and high yielding) and 0 = otherwise. We estimated productivity as the total cocoa beans produced per hectare per farmer – for each farmer, productivity was measured as $\left(\frac{total\ cocoa\ beans\ (kg)}{total\ farm\ size\ (ha)}\right)$.

Table 1a presents summary statistics of the dependent variables, i.e., means and standard errors. From the analysis, the sampled farmers (extension participants and non-participants) produced an average productivity of 598.065 kg/ha, less than the average potential productivity of 1000 kg/ha projected by COCOBOD (Barrientos et al. 2008). In addition, 83.90% of the farmers adopted hybrid cocoa seedlings.

3.6.3. Covariates

Several thoroughly chosen control variables were used in the study, as the validity or otherwise of our estimates depends on the strength of the explanatory variables used in both the logistic and linear regressions. Previous studies have revealed that our selected covariates have a statistically significant effect on our dependent variables (Asante et al. 2021; Etaware 2022; Donkor et al. 2023).

The selected covariates include farmer factors like gender, household size, years spent in school, availability of off-farm income and farming experience. We also used variables such as farm size, farm ownership status, average age of cocoa trees (AAOCTS) and cultivation of crops other than cocoa to account for the effect of farm-specific characteristics on the dependent variables. Institutional factors like farmer group status, membership of a local savings group, access to credit, and television/radio ownership were used in our analyses, while other variables such as number of good cocoa management training courses received per year (NGCMT) and distance from farm to district market centre (DTDMC) were added to capture the impact of market proximity, access to information and social capital.

Table 1: Descriptive statistics of the variables for the research

Variables	Description	Total Sample **(a)**	Parts.[a] **(b)**	**(c)** Non-parts.[a]	Diff.[b] **(d)**	p-value
		Mean (Std. Err.)	Mean (Std. Err.)	Mean (Std. Err.)	Mean (Std. Err.)	**(e)**
Dependent Variables						
Hybridcocoa	Dummy: 1 = if famer adopts hybrid cocoa seedlings; 0 = otherwise	0.839 (0.018)	0.863 (0.020)	0.780 (0.037)	0.083 (0.039)	0.036
Productivity	Total cocoa beans produced (kg) per hectare	598.065 (18.583)	684.866 (22.999)	391.293 (21.439)	293.573 (38.133)	0.000
Covariates						
Gender	Dummy: 1 = male; and 0, female	0.644 (0.024)	0.638 (0.028)	0.659 (0.043)	0.020 (0.052)	0.694
Education	Number of years spent in school	6.413 (0.249)	6.433 (0.293)	6.366 (0.474)	0.068 (0.547)	0.902
Household size	Number of persons in a farmer's household (adults + children)	5.070 (0.111)	5.222 (0.133)	4.707 (0.196)	0.515 (0.241)	0.034
Farming experience	Number of years spent in cocoa farming per farmer	19.353 (0.572)	19.116 (0.653)	19.919 (1.154)	-0.803 (1.255)	0.523
Farm size	Total size of cocoa farm(s) per farmer in ha	1.813 (0.062)	1.855 (0.077)	1.713 (0.098)	0.142 (0.135)	0.295
Farm ownership	Dummy: 1 = personal farm ownership; 0 otherwise.	0.659 (0.023)	0.741 (0.026)	0.463 (0.045)	0.277 (0.049)	0.000

	Average age of the cocoa trees in years	12.733	11.874	14.780	-2.907	
AAOCTS		(0.583)	(0.727)	(0.922)	(1.271)	0.023
Off-farm	Dummy: 1 = farmer earns off-farm	0.966	0.973	0.951	0.021	
income	income; 0 = otherwise	(0.009)	(0.010)	(0.020)	(0.019)	0.269
	Dummy: 1 = if the farmer grew any other	0.596	0.608	0.569	0.038	
Other crops	crop aside from cocoa; 0 = otherwise	(0.024)	(0.029)	(0.045)	(0.053)	0.468
Access to	Dummy: 1 = if the farmer takes credit; 0 =	0.245	0.287	0.146	0.140	
credit	otherwise	(0.021)	(0.026)	(0.032)	(0.046)	0.002
Local saving	Dummy: 1 = farmer belongs to local	0.313	0.355	0.211	-0.066	
group	savings group; 0 = otherwise	(0.023)	(0.028)	(0.037)	(0.049)	0.004
	Dummy: 1 = farmer owns a television or	0.724	0.802	0.537	0.265	
TV_radio	radio; 0 = otherwise	(0.265)	(0.023)	(0.045)	(0.046)	0.000
	Dummy: 1 = farmer group member; and 0,	0.526	0.625	0.293	0.332	
Farmer group	otherwise	(0.025)	(0.028)	(0.041)	(0.051)	0.000
	Number of good cocoa farming training	4.173	4.341	3.772	0.569	
NGCMT	received per farmer per year.	(0.052)	(0.047)	(0.128)	(0.110)	0.000
	Distance from cocoa farm to the district	45.493	47.368	41.027	6.341	
DTDMC	market centre (km)	(2.504)	(3.382)	(2.588)	(5.485)	0.248

[a] Participants (n = 293) and non-participants (n = 123) of cocoa extension programmes; total sample (n = 416)

[b] Mean difference using Welch’s t-test for comparison of means

Source: Estimates from the author’s analyses

Table 1 shows the selected covariates, their description, means and standard errors for the total sample of farmers (extension participants and non-participants). A total of 15 covariates were used in all our models, i.e. logit and linear regression. Table 1a shows that the average number of years of education per farmer is 6.413, i.e. the average years of schooling per farmer is low (primary education). Most of the farmers surveyed were male (64.40%), confirming the literature that cocoa is a "man's crop" (Bessa et al. 2021). However, 35.60% of female participation is an improvement over 27% of female participation in Ecuador (Kuhna et al. 2023)**.** The average house size per farmer is 5 persons (adults + children). In addition, the respondents had approximately 19 years of farming experience and cultivated 1.813 ha of land, most of which (65.90%) was owned by the farmers themselves. The farmers had relatively young cocoa trees (12.733 years), and most of them earned off-farm income (96.60%) and cultivated other crops (59.60%), a good source of financial resources for farm investment and household welfare. However, only 31.3% of the farmers belong to local savings groups, while 24.5% of them take loans (formal and informal). In addition, 72.40% have television and/or radio, i.e. access to information. More than half of the farmers, 52.60%, belong to one or more farmer groups, while each farmer receives an average of 4 training sessions on good cocoa farming practices from government and private agencies. Proximity to markets is a challenge for farmers as the average distance between farms and the nearest district market is 45.493 km. This can affect farmers' ability to buy and transport inputs and sell other farm produce.

4. Results

4.1. Descriptive statistics of the research variables

Table 1b-e presents the means and standard errors, differences in means and the t-test of comparison of the means of extension participants and non-participants for the variables used for this research. From the results, 84% of the farmers adopted hybrid seedlings, but 8% more of the extension participants (86%) adopted hybrid seedlings than the non-participants (78%). In addition, the participants produced 684.866 kg/ha on average, 293.573 kg/ha more than the non-participants (391.293 kg/ha). The significant positive variances between farmers who participate in cocoa extension and those who do not give us a glimpse of our study hypotheses that farmers participating in cocoa extension programmes may adopt improved cocoa seedlings, which can consequently increase their productivity. We will confirm these findings with our inferential analyses.

Eight of the 15 covariates indicate significant differences between farmers who participate in extension and those who do not. In addition to having larger households, farmers who participate have higher odds than non-participating farmers in terms of personal farm ownership status, credit availability, TV/radio ownership, farmer group, NGCMT, and DTDMC. However, the non-participants had older cocoa trees than the participants – a reasonable explanation for the lower productivity of the non-participants. The other factors show no statistically significant variations between extension members and non-members (refer to Table 1).

4.2. Factors determining farmer participation in cocoa extension programmes

Table 2 displays estimates of the logit model employed to assess our first objective. With a Pseudo R-square of 0.199, our logistic regression model generally fits at the 0.001 level of statistical significance (Prob > Chi^2 = 0.000).

Table 2: Logistic regression showing the drivers of farmer participation in extension programmes

Variables	Coef.	Std. Err.	P>z[a]	Av. ME[b]	Std. Err.	P>z[a]
Gender	0.190	0.285	0.505	0.030	0.045	0.504
Education	-0.006	0.028	0.824	-0.001	0.004	0.824
Household size	0.124	0.060	0.038	0.020	0.009	0.035
Farming experience	-0.036	0.012	0.003	-0.006	0.002	0.002
Farm size	0.154	0.128	0.227	0.025	0.020	0.225
Farm ownership	1.521	0.284	0.000	0.242	0.040	0.000
AAOCTS	-0.016	0.010	0.115	-0.003	0.002	0.112
Off-farm income	1.264	0.660	0.055	0.201	0.103	0.052
Other crops	0.096	0.252	0.703	0.015	0.040	0.703
Access to credit	0.133	0.295	0.652	0.021	0.047	0.652
Local saving group	-0.186	0.307	0.544	-0.030	0.049	0.544
TV_radio	0.153	0.334	0.648	0.024	0.053	0.647
Farmer group	0.989	0.273	0.000	0.157	0.041	0.000
NGCMT	0.533	0.125	0.000	0.085	0.018	0.000
DTDMC	0.007	0.004	0.061	0.001	0.001	0.057
_cons	-4.393	1.103	0.000	-	-	
No. of Obs.	416					
Prob > Chi^2	0.000					
Pseudo R-square	0.200					
Log likelihood	- 202.051					

[a] Statistical level of significance of the variables

[b] Average marginal effects

Source: Estimates from the author's analyses

The result suggests that variations in the explanatory variables can account for as much as 19.90% of the variation in extension participation. The low Pseudo R-square can be explained by the large number of dummy variables captured as covariates in our model. At the 0.01, 0.05, and 0.1 levels, seven (7) out of fifteen (15) covariates contained in our analyses are statistically significant.

Regarding the farm and farmer characteristics, the findings indicate that farmer engagement in cocoa extension programmes is positively and statistically significantly (0.020) impacted by household size. Increasing household size by a member increases a farmer's chance of participating in cocoa extension by 2% (see Table 2). However, the only factor that has statistically significant adverse effects on extension participation is farming experience. The findings denote that farmers' propensity to participate in cocoa extension programmes decreases by 0.6% (-0.006) as their extent of cocoa growing experience increases. Thus, farmers with less experience tend to rely more on extension training to improve their farm management and productivity, while experienced farmers rely more on their years of cocoa farming than on extension training. Farmers' decision to participate in an extension programme is most influenced by their access to income outside cocoa farming. Farmers with access to off-farm income are 20.1% (0.201) more likely to participate in a cocoa extension programme, suggesting that farmers with other sources of income are willing to participate in extension programmes that may influence their usage of sustainable technologies. The result also shows that personal ownership of a farm has the strongest impact on the decision to participate or not. For example, farmers' propensity to participate in a cocoa extension programme increases by 24.2% (0.242) with personal ownership.

The results for institutional and geographic factors show that farmer group membership status, a proxy for social capital, has a statistically significant effect of 0.157 on farmer participation in cocoa extension (Table 2). According to the findings, cocoa farmer group members are 15.7% more inclined to enrol in cocoa extension. The high marginal effects of farmer groups show the significance of social groupings in their members' choices. Moreover, the propensity of farmers to participate in cocoa extension or otherwise increases by 8.5% (0.085) as the number of Good Cocoa

Management Training (NGCMT) they receive increases. Finally, the proximity of the farm to the nearest district market (DTDMC) positively influences farmers' decision to participate in cocoa extension, but its impact is minimal in terms of marginal effect (0.001). The result suggests that farmers with long distances from their farms to the nearest district markets will take advantage of cocoa extension programmes and benefit from extension training and inputs provided by extension programmes.

The remaining variables, gender, education, farm size, average age of cocoa trees, growing other crops, membership of a local savings group, taking credit and ownership of television or radio, a proxy for access to information, have no statistical significance on farmers' participation decision.

4.3. The impact of extension participation and other variables on adoption of improved hybrid cocoa and productivity

4.3.1. Statistical significance of the logit and linear regression models

Table 3a-b gives our logistic and linear regression estimates of the impacts of participating in cocoa extension programmes on farmers' hybrid seedling adoption and productivity. The Prob > Chi^2 (0.000) and Prob >F (0.000) values indicate that the logit and linear regression are statistically significant at the 0.01 level (see Table 3a-b). In the hybrid cocoa seedling adoption model, six (6) of the 16 explanatory variables show 0.01, 0.05, and 0.01 statistical significance (Table 3a). Comparably, our linear regression model, which illustrates how hybrid seedlings adoption affects cocoa productivity, has a respectable adjusted R-square (0.310) and shows 0.01 statistical significance. The model's large number of dummy variables explains the somewhat low adjusted R-square. Eight (8) out of 16 of the covariates have significant effects on cocoa productivity (see Table 3b).

4.3.1. Impact of participation in cocoa extension on farmers' uptake of hybrid cocoa seedling and productivity

Table 3a presents our findings on the impact of cocoa extension programmes on adoption of hybrid seedlings. The results indicate that involvement in the cocoa extension programme positively and significantly influences the desire to grow hybrid cocoa seedlings (i.e., at the 0.01 level). The variable that has the biggest marginal impact on farmers' use of hybrid seedlings is participation in cocoa extension. Specifically, farmers who participate in cocoa extension programmes have 10.6% more chances to grow hybrid cocoa seedlings than non-participants. The results of hybrid seedling adoption imply that farmers will adopt high-yielding, disease-resistant hybrid cocoa seedlings to improve the long-term productivity of their farms if they are exposed to extension training and education through public or private cocoa extension programmes.

Table 3: Logistic and linear regressions demonstrating the impact of cocoa extension participation on farmer usage of hybrid cocoa seedlings and productivity

	Logit – Hybrid Cocoa Seedling Adoption **(a)**					Linear Regression – Productivity **(b)**		
Variables	Coef.	Std. Err.	P>z[a]	Av. ME[b]	Std. Err.	Coef.	Std. Err.	P>t[a]
Extension participation	0.943	0.361	0.008	0.106	0.040	-	-	-
Hybridcocoa	-	-	-	-	-	195.987	45.176	0.000
Gender	0.540	0.338	0.108	0.061	0.038	35.772	35.629	0.316
Education	0.062	0.034	0.061	0.007	0.004	13.312	3.330	0.000
Household size	-0.004	0.067	0.956	0.000	0.007	35.007	7.006	0.000
Farming experience	-0.042	0.012	0.000	-0.005	0.001	-0.502	1.554	0.747
Farm size	0.018	0.130	0.890	0.002	0.015	-86.379	14.138	0.000
Farm ownership	-0.289	0.380	0.446	-0.032	0.043	-30.079	36.143	0.406
AAOCTS	0.005	0.014	0.711	0.001	0.002	0.723	1.419	0.611
Off-farm income	-1.622	1.176	0.166	-0.182	0.132	-293.636	88.872	0.001
Other crops	-0.705	0.325	0.029	-0.079	0.036	-20.478	32.246	0.526
Access to credit	0.545	0.397	0.168	0.061	0.044	-34.517	36.559	0.346
Local saving group	0.754	0.461	0.100	0.085	0.052	-297.186	40.344	0.000
TV_radio	0.353	0.434	0.415	0.040	0.049	100.949	43.350	0.020
Farmer group	-0.147	0.355	0.678	-0.017	0.040	93.302	34.828	0.008
NGCMT	-0.107	0.151	0.479	-0.012	0.017	-7.533	15.962	0.637
DTDMC	-0.007	0.002	0.003	-0.001	0.000	0.423	0.310	0.173
_cons	3.706	1.536	0.016	-	-	602.824	144.503	0.000

Number of Obs.	416	416
Prob > Chi^2/F	0.000	0.000
Pseudo R-square/R-square	0.167	0.337
Adj. R-square	-	0.310
Log likelihood	-153.017	-

[a] Statistical level of significance of the variables

[b] Average marginal effects

Source: Estimates from the author's analyses

We then added hybrid seedling adoption as an explanatory variable in our second model to examine its consequential effect on cocoa productivity (H2). The result in Table 3b shows that adoption of hybrid cocoa seedlings increases a farmer's productivity by 195.987 kg/ha, holding other factors constant; this effect is positive and statistically significant. Thus, participation in extension programmes increases hybrid cocoa seedling usage, which in turn increases cocoa productivity.

4.3.2. Impact of additional variables on productivity and farmers' willingness to use hybrid cocoa seedlings

Years of schooling among farmers has a direct and significant influence on hybrid seedling uptake and productivity among farmer characteristics. For example, one additional year of education increases farmers' propensity to adopt hybrid seedlings by 0.7% (0.007) and increases cocoa productivity by 13.312 kg/ha. Asfaw et al. (2012) argued that more educated Tanzanian and Ethiopian smallholders are strongly inclined to use advanced technology, which can increase farm output. Although the size of a farmer's household significantly influences productivity (35.007 kg/ha), it has no statistical impact on farmers' usage of hybrid seedlings. Given the labour intensity of cocoa farming, larger household sizes tend to have more family labour, i.e. unpaid labour, which can assist in farm management and increase production efficiency. However, experienced cocoa farmers are less inclined to grow a hybrid cocoa seedling. On the other hand, its marginal effect (-0.005) is negligible. Older and more experienced farmers are risk-averse (Attipoe et al. 2021) and reluctant to try novel technologies. The authors argued that older peasant cocoa farmers in Ghana believe that their orthodox cocoa farming is more suited to the geographical environment, so technical advice from COCOBOD extension agents, who are often not indigenous to the area, to adopt new technologies may negatively influence their business. Furthermore, cocoa productivity is negatively impacted by farm size. For instance, productivity decreases by 86.379 kg/ha when a farm's size is increased by one hectare. Larger farms suggest that the farmer might not be able to manage the farm effectively, which might reduce productivity because most cocoa plantations in Ghanan are not mechanised. Besides, farmers with many or larger cocoa plantations can have insufficient funds to manage the farms effectively since most farmers are resource-poor Attipoe et al. (2021). Similarly, cocoa productivity is negatively affected by access to off-farm income (-293.636 kg/ha). Similarly, growing other crops reduces farmers' labour time and attention to their cocoa farms, hence its negative impact (-0.079) on farmers' adoption of better technologies (i.e. hybrid seedlings) and productivity, although the latter was not statistically significant. According to Okoffo et al. (2016), the production of cocoa requires all-year-round fam management practices, such as fertiliser application, pruning, and weed and fungal control, to accrue high farm productivity. Cultivating other crops and participating in other income activities may generate income; however, it decreases active engagement in cocoa farming and reduces productivity.

Furthermore, only access to credit does not show statistical significance on hybrid seedling adoption or productivity, out of the four institutional factors. By contrast, belonging to a local savings group has a significant influence on adopting a hybrid seedling and productivity. Thus, membership in a local savings group lowers productivity by 297.186 kg/ha but improves the chances of cocoa farmers adopting hybrid seedlings by 8.5%. The fact that cocoa farmers often do not reinvest much of their savings, which are often the proceeds of cocoa bean sales, into critical farm improvements explains the unexpected drop in output. The savings are often spent on non-farm household expenses, such as paying school fees for the farmer's children, utility bills, etc. In contrast to membership in a local savings group, ownership of a television or radio, i.e., information accessibility, positively affects cocoa productivity (100.949 kg/ha). This finding suggests that farmers owning a television or radio are likely to have adequate agricultural information and education and can make informed decisions that can improve their productivity. Similarly, the results indicate that belonging to a farmer group raises cocoa productivity by 93.302 kg/ha, although it has no statistical significance on growing hybrid seedlings. The result demonstrates the importance of social groupings on farmers’ usage of innovation and agricultural development.

Furthermore, the adoption of hybrid seedlings is negatively impacted (-0.001) by the cocoa farm's proximity to the closest district market (DTDMC). The negative effect may be related to the fact that most of the inputs used by farmers, including hybrid seedlings, are sold in the district capitals. Subsidised hybrid seedlings, fertiliser and other inputs from the government are available from COCOBOD offices in the district capitals. Therefore, long distances from the farm to the district capitals can increase the cost of transporting seedlings and consequently affect adoption. This is in line with the literature that proximity to markets and offices of technology implementation agencies improves farmers' adoption of new technologies (Diiro 2013; Tefera et al. 2016).

5. Discussion

We analysed the determinants of farmer participation in cocoa extension programmes, the impact of participation on farmers' adoption of improved hybrid seedlings, and its subsequent influence on cocoa productivity. Our results suggest that farmer adoption of hybrid seedlings is positively influenced by participation in cocoa extension programmes, which in turn increases cocoa productivity. As a result, we compare the findings with the literature and explain the findings considering our research question and hypotheses in this chapter.

In relation to our first objective (see subsection 2.1), our findings indicate that the size of a farmer household, farm ownership status, farming experience, off-farm income, farmer group membership, number of good cocoa management training received (NGCMT), and distance from cocoa farm to district market (DTDMC) are the statistically significant drivers of farmers' decision to participate in extension. Household size and off-farm income are the farmer’s and farm characteristics that positively impact participation. To manage their cocoa farms, farmers with larger households and incomes from sources other than farming have greater access to unpaid labour and financial resources. These resources give the farmer the scope to participate in extension training and to afford the initial cost of some of the expensive technologies (e.g. artificial hand pollination) promoted by cocoa extension agents. Additionally, Jamilu et al. (2015) discovered a direct interplay between extension participation and household size and off-farm access. Similarly, farm ownership status positively affects extension participation, implying that direct ownership of the farm motivates farmers to participate in extension programmes to enhance their farm management practices and the long-term productivity of the farm than indirect ownership such as 'abunu'[1]. Nahayo et al. (2017) used land acquisition as a proxy for farm ownership and found a direct effect on farmers' decisions to participate or not in crop intensification extension programmes in Rwanda. On the other hand, we found that high levels of farm experience made farmers reluctant to participate in cocoa extension programmes. Older cocoa farmers tend to trust their years of experience in cocoa farming more than what they perceive as the 'book knowledge' of young extension agents. They are also sceptical about new technologies introduced by extension programmes and are therefore less likely to participate. Adesina and Eforuoku (2016) and Ogunjobi et al. (2022) observed that farmers with high experience are expected to participate in extension, which is contrary to our findings. The fact that their research concentrated on food crop smallholders - who may be more receptive to adopting new techniques as they gain experience - as opposed to cash crop producers, as in our study, may explain the discrepancy in results. Among the institutional and geographic variables, farmer group status, the number of good cocoa management training sessions and the distance from the cocoa farms to district market centres have positive impacts on participation in cocoa extension programmes. Cocoa farmers in Ghana often learn from other farmers. Farmer groups, such as cooperatives and other farmer organisations, therefore, have a major impact on farmer participation in extension programmes. Farmers who have been trained in good cocoa management practices and are reaping the benefits are also more likely to enrol in cocoa extension programmes and access training, technical assistance and free or subsidised programmes such as the Cocoa Rehabilitation Programme, artificial hand pollination,

[1] Under an 'abunu' land tenure agreement, a landowner grants someone permission to grow cocoa on a piece of land that would normally remain uncultivated. Once the trees are established, the cocoa farm is divided among the lessor (landowner) and lessee. This ensures the lessee's (farmer) traditional land tenure (Bessa et al. 2021).

free mass spraying and take COCOBOD’s fertiliser subsidy. Proximity of farm to district markets positively affects extension participation. In our research area, long-distance farmers depend on cocoa extension agents for frequent visits and on-farm training, as they often have limited access to other forms of information such as radio, television, telephone networks, etc. They also develop close relationships with extension agents. They also develop close relationships with extension agents so that when they come to visit the farm, the farmer can contact the agents to buy input for them from the district markets, saving the farmer transport costs. This may explain the positive relationship between distance from farms to district markets and participation in cocoa extension programmes. The above findings are consistent with studies that found significant effects of farmer groups, agricultural training and distance on farmers' participation in agricultural programmes and extension (Adesina & Eforuoku 2016; Omotesho et al. 2016; Daniso 2022).

Regarding the first hypothesis, our results show that participating in an extension programme raises farmers’ propensity to adopt hybrid cocoa seedlings and vice versa. The result conforms with our research assumption (H1) and the literature on the direct effect of extension on the adoption of new crop varieties and agricultural technologies by Xu et al. (2022) and Tomoki et al. (2023). Many improved cocoa varieties that are resistant to disease and drought have been developed by CRIG of Ghana. These seedlings are also high yielding with short maturity and long production life. Ghana's COCOBOD has recently stepped up its efforts to persuade farmers to use these enhanced seedlings as the impact of climate disruption on cocoa yields becomes more apparent. According to Yamano et al. (2018), it's critical to use extension to teach farmers the advantages of crop types that can tolerate stress. COCOBOD, in conjunction with several business groups, has developed friendly smartphone applications like Cocoa-Link, Farming Solution, and MergeData to provide farmers with critical climatic and other information. These extension programmes, such as the COCOBOD's free hybrid seedling, provide a substantial contribution to promoting scientific and technical advancement (Gao et al. 2020) and, therefore, have a direct impact on farmers' adoption of hybrid seedlings.

We also analysed the impact of adopting hybrid cocoa on productivity in our second model (see Table 3b). Our linear regression model's results demonstrate that adopting hybrid seedlings raises cocoa productivity. Compared to non-adopters, farmers who used hybrid seedlings produced 77.973 kg/ha more. This supports our second hypothesis (H2) that adopting enhanced, disease-tolerant, high-yielding hybrid seedlings boost cocoa productivity. The best means of raising crop yields and improving farmers' living standards in developing countries is to disseminate improved crop varieties adapted to regional agroclimatic conditions (Evenson & Gollin 2003). In a paper on farmers' benefits from adopting agrotechnology, Takahashi et al. (2019) concluded that improved crop varieties generally increase productivity, reduce poverty and enhance the welfare of farmer households. The CRIG of Ghana has developed a range of cocoa seedlings with improved maturity, stem diameter and production efficiency to suit local conditions (Gockowski et al. 2013; Kongor et al. 2018). Through subsidies, COCOBOD motivates farmers to adopt these improved hybrid varieties, which are high-yielding and resistant to diseases, to increase productivity on the reduced land they cultivate. The hybrids also help to address the challenges of drought, pests and diseases associated with rural farming, as most of the new cocoa varieties have improved drought and disease resistance (Cocoa Supply 2023). Obeng-Bio et al. (2022) found that improved cocoa varieties in Ghana have high seedling survival (i.e. 92% to 96%) and high yields, up to 2816 kg/ha. Therefore, farmers growing heirloom cocoa seedlings (local varieties) typically experience high crop losses due to their low productivity and susceptibility to diseases such as black pod (Cocoa Supply 2023).

Through COCOBOD, the Ghanaian government has implemented projects that have increased the farmer-extension agent ratio in the cocoa sector from 1:1500 for the overall agricultural sector to 1:700 by 2020 (MoFA 2022; Jones et al. 2023). Innovative cocoa extension programmes introduced by the government, such as the free hybrid seedlings and the rehabilitation programmes, help farmers replace old, unproductive cocoa trees with improved, high-yielding varieties, which helps to increase the productivity of participants in the rehabilitation extension programme (Obeng-Bio et al. 2022). Furthermore, the results conform with the literature that extension programmes can enhance technology adoption, which in turn increases agricultural output (Elias et al. 2013; Chimoita et al. 2015; Alemu et al. 2016; Ateka et al. 2019). Our research, therefore, demonstrates that involvement in cocoa extension programmes contributes to the uptake of improved hybrid seedlings by peasant cocoa farmers, thereby improving cocoa productivity.

6. Conclusions

The thesis assessed the drivers of participating in cocoa extension programmes, the impact of such participation on planting improved hybrid seedlings, and its subsequent effect on cocoa productivity. We used logistic and linear regressions to investigate data gathered from 416 smallholder cocoa producers in the two Ahafo-Ano districts of Ghana. Farmers' decision to participate in cocoa extension programmes is positively associated with several factors, including large household size, personal farm ownership, accessing off-farm income, membership of farmer groups, increased training on good cocoa management, and longer distances between cocoa farms and district markets. On the other hand, increased years of experience growing cocoa had a detrimental impact on participation. Our results indicate that farmers' participation in cocoa extension programmes directly influences their decision to adopt improved hybrid cocoa seedling. Similarly, the productivity of enrolled farmers was positively and significantly affected by adopting hybrid cocoa seedlings and participating in cocoa extension. The study confirms that extension programmes, both publicly and privately supported, significantly encourage smallholders to adopt improved cocoa varieties or seedlings, which in turn increases productivity. As COCOBOD seeks to raise domestic cocoa output, extension education on high-yielding, disease- and drought-tolerant seedlings should be prioritised amid recent climate challenges. Extension can be a substitute for formal education in regions where cocoa farmers have low levels of formal education. Thus, it should come as no surprise that farmers' adoption of better cocoa hybrid seedlings and cocoa productivity are increased by both high years of education and extension participation. With the help of COCOBOD and non-governmental organisations working in the cocoa industry, the Ghanaian government can concentrate on funding ongoing cocoa extension initiatives that give farmers access to improved cocoa seedlings produced by the Cocoa

Research Institute to boost cocoa productivity. Rather than creating a universally hybrid cocoa variety for the entire country, CRIG should invest in developing new varieties suited to the cocoa-growing regions' specific climatic and vegetation requirements. This should be combined with an effective seedling supply and distribution to lessen the negative effect of proximity (i.e., DTDMC) on farmers' adoption of the hybrid seedlings. Therefore, rather than using the MoFA district offices, which are often distant from the farming communities, COCOBOD could think about distributing the hybrid seedlings through the cocoa farmer groups. Because farmer groups have a positive effect on participation, distributing the seedlings through cocoa farmer associations will improve farmers' participation in extension (see Table 2). Age groups should inform the targeting and design of cocoa extension programmes since age is synonymous with experience in cocoa farming. Older farmers may find direct farm visits and participatory extension methods more practical and advantageous than methods that need them to travel far from their farms. This could motivate them to take part in extension initiatives, which would increase overall cocoa production.

Despite its merits, our research has a few limitations that should be addressed in additional research. To accurately estimate the effects of programmes such as extension, it is necessary to account for both observable and unobservable determinants that influence a farmer's chances of receiving the treatment (extension participation) and the outcomes (hybrid adoption and productivity). If random assignment is not used, selection bias could arise. Therefore, we suggest applying counterfactual analytical methods to account for both observable and unobservable biases in the outcome. In addition, the data used, particularly the total kg of cocoa beans produced, may be subject to recall problems as farmers may not be able to accurately account for previous years' production. To reduce the variability in the numbers, we compared the data provided by the farmers with the records of cocoa beans sold kept by the community Cocoa Purchasing Clerks.

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Appendices

Appendix 1: Correlation coefficients of the covariates used for the research

Variables	Gender	Education	Household size	Farming experience	Off-farm income	Farm size	Farm ownership	AAOCTS	Other crops
Gender	1.000								
Education	0.186	1.000							
Household size	0.056	-0.107	1.000						
Farming experience	0.005	-0.271	0.067	1.000					
Off-farm income	-0.055	0.007	-0.048	-0.080	1.000				
Farm size	0.227	-0.172	0.100	0.356	-0.169	1.000			
Farm ownership	-0.217	-0.018	-0.005	0.182	-0.078	0.009	1.000		
AAOCTS	0.169	-0.042	0.075	0.109	-0.056	0.044	-0.193	1.000	
Other crops	0.023	-0.026	0.010	0.049	-0.045	0.066	0.079	-0.103	1.000
Access to credit	0.038	0.071	-0.025	-0.065	0.013	-0.033	0.045	-0.040	0.036
Local saving group	0.064	0.151	-0.058	-0.085	-0.109	-0.164	-0.044	0.214	-0.097
TV_radio	0.053	0.000	0.112	0.070	0.000	0.154	-0.017	-0.072	0.096
Farmer group	-0.031	-0.022	-0.007	0.159	0.037	0.114	0.241	-0.148	0.083

NGCMT	0.065	0.000	0.062	0.096	-0.070	0.094	-0.098	0.140	-0.060
DTDMC	0.047	0.026	-0.046	-0.044	-0.007	-0.006	-0.074	0.093	-0.044

	Access to credit	Local saving group	TV_radio	Farmer group	NGCMT	DTDMC
Access to credit	1.000					
Local saving group	0.099	1.000				
TV_radio	-0.030	-0.460	1.000			
Farmer group	0.037	-0.119	0.116	1.000		
NGCMT	0.044	0.090	-0.031	0.278	1.000	
DTDMC	0.055	0.064	-0.069	-0.086	0.073	1.000

Source: Estimates from the author’s analyses

Appendix 2: Selected questions from the main questionnaire relevant for this thesis

Location and biography

1. Name of Cocoa community…
2. Is there a cooperative in the community?
3. Distance from house to cooperative meeting grounds (minutes of walk)

Socio-economic characteristics

4. Age of respondent in years………………………………
5. Gender …………… [1] male [0] female
6. Where do you stay…….. [1] hamlet [2] community [3] other, specify
7. Household size……………………………….
8. Do you own a TV/radio in your household…………. [1] yes [0] no
9. Years of formal education (in years)…
10. How long have you been into cocoa farming (in years)…

Farm characteristics

11. What is your cocoa plot size (in acres)…
12. What is your ownership status [1] direct owner [2] farm manager [3] share-cropper [4] renting [5] other, specify
13. Do you have hybrid cocoa plants or use hybrid seedlings on your farm? [1] yes [0] no
14. What is the age of your farm?
15. How much cocoa beans did you harvest during the last cocoa season from your farm (in bags)?......................
16. How much cocoa beans did you harvest last 2years from your farm (in bags)?.......

17. Are you a member of any cocoa cooperative?……..[1] yes [2] no
18. Are you aware of climate change? .. [1] yes [0] no

Education, training and information

19. Have you participated in any cocoa extension programme in the last 2 cocoa seasons? [1] yes [0] no
20. How much training have you received on good cocoa management practices in the last 3 years?............
21. Service from extension agents have improve over the last 3 years [ ] Strongly Disagree [ ] Partly Agree [ ] Neither agree nor disagree [ ] Partly Agree [ ] Strongly Agree
22. Access to relevant market information have improved over the last 3 years [ ] Strongly Disagree [ ] Partly Agree [ ] Neither agree nor disagree [ ] Partly Agree [ ] Strongly Agree
23. Opportunity for further training has increased over the last 3 years [ ] Strongly Disagree [ ] Partly Agree [ ] Neither agree nor disagree [ ] Partly Agree [ ] Strongly Agree
24. You have better chance to mutually share experience with other farmers than 3 years [ ] Strongly Disagree [ ] Partly Agree [ ] Neither agree nor disagree [ ] Partly Agree [ ] Strongly Agree