RESEARCH ARTICLE

Rainforest Alliance-UTZ cocoa certification scheme adoption: Determinants and financial implications for cocoa production in the Centre region of Cameroon

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Abstract

This study evaluates the level of adoption of the Rainforest Alliance-UTZ cocoa certification scheme in the Centre region of Cameroon, ascertains the drivers of adoption, and evaluates the financial implications of the levels of adoption. Using cross-sectional data obtained from 100 cocoa growers in the Central region of Cameroon and employing a Generalised Ordered Logit estimation technique alongside a one-way ANOVA test and Tukey’s test for post-hoc estimations, we show that 50%, 17%, and 33% of cocoa growers are complete adopters, partial adopters, and non-adopters of the Rainforest Alliance-UTZ cocoa certification scheme, respectively. The findings also reveal that the likelihood of having partial or complete adoption is higher among farmers who have introduced orange trees in their orchards, own more extensive orchards, and have more years of experience in cocoa farming. Furthermore, the likelihood of having complete adoption is higher for farmers with a lower planting density in their orchards and a tertiary level of schooling. Farmer’s age has a mitigated effect on the likelihood of adopting certification schemes by reducing the likelihood of having partial or complete adoption against non-adoption and at the same time raising the likelihood of complete adoption against no or partial adoption. The study also concludes that the financial performance of cocoa growers varies based on their level of adoption of the Rainforest Alliance-UTZ certification scheme. Farmers who have achieved certification status tend to have higher farm earnings. Based on these findings, non-adopters and partial adopters are encouraged to fully adhere to the Rainforest Alliance-UTZ certification standards. By doing so, they can increase their financial gains, enhance their livelihoods, and reduce the negative environmental impacts of cocoa farming.
For the past two decades, third-party sustainability certification has become the most widely used method to promote sustainability in the global cocoa-chocolate chain. The certification process requires cocoa growers to meet specific economic, social, and ecological standards, such as growing cocoa in agroforestry systems, establishing working contracts for farm workers, and prohibiting the use of underage workers. Unfortunately, less than one third of cocoa grown in Cameroon meets these certification standards. In our study, we introduce a novel technique where we categorize certification status as no adoption, partial adoption, or complete adoption. We show that farmers with a tertiary level of schooling, larger orchard size practicing cocoa agroforestry-based systems with mango (Mangifera indica), and oranges (Citrus sinensis) have higher levels of adoption of cocoa certification standards. Our research also demonstrates that complete adoption of cocoa certification standards leads to higher farm earnings and a higher benefit-cost ratio. Therefore, widespread adoption of certification standards can enable cocoa growers to raise their earnings while protecting the environment.

1. Introduction

Cocoa is one of the main sources of foreign exchange income for many African nations, including Cameroon, Côte d’Ivoire, and Ghana [1]. In these countries, cocoa is the primary agricultural commodity, predominantly cultivated by small farmers who depend on it as their main source of income. However, the majority of cocoa farmers in this region, which has the largest cocoa production, do not earn a decent living income from cocoa production [2].

Thus, the cocoa sector is far from being free of sustainability issues. Sustainability in the cocoa value chain involves environmental, social, and economic concerns. Environmental sustainability in the cocoa sector primarily focuses on deforestation and forest degradation, as well as the use of agrochemicals and adapting to climate change [2]. Social sustainability pertains to protecting human rights including labor conditions, eliminating child labor and promoting gender equality [2,3]. Economic sustainability is primarily about ensuring fair and stable income for cocoa farmers [3].

These sustainability issues have garnered widespread public attention since the early 2000s [2] and have placed sustainable cocoa production on the political agenda of various stakeholders at different levels [4]. As a result, there has been a rise in initiatives, such as certification mechanisms driven by the market, which allow the government to indirectly establish regulations for cocoa production [5]. Third-party sustainability certification has become the most commonly used method to promote sustainability in the Global Cocoa Chocolate Chain since the late 2000s [2,4].

Certified cocoa ensures that smallholders meet specific economic, social, or ecological standards, potentially enabling them to sell their certified cocoa at higher prices and increase profits [6]. In the early twentieth century, products were first certified as "organic," "fair trade," "UTZ," and "Rainforest Alliance" products [7]. The Rainforest Alliance system was initially implemented by cocoa exporters in Cameroon, followed by the UTZ standard, and eventually the Fairtrade and Organic systems [8].

The UTZ standard seeks to raise cocoa production’s societal standards to levels consistent with those set by the International Labour Organisation. UTZ encourages farmers to use sound agricultural practices, such as banning the use of restricted pesticides, growing cocoa in an agroforestry system with at least eighteen trees per hectare, and keeping bean moisture
content at 7% [9]. In addition to agricultural practices, UTZ upholds societal norms like the requirement that plantation workers have an employment contract and the ban on underage workers performing tasks that are hazardous or likely to endanger their physical or moral well-being [8]. The Rainforest Alliance also supports sustainable livelihoods by altering land-use patterns, commercial behaviour, and consumer behaviour [10] while focusing on ecosystem preservation [9]. On the other hand, fair trade aims to improve the lives of workers [9]. Despite the distinct qualities of each certification standard, they all strive to enhance societal wellbeing.

Since 2018, a merger between the UTZ and Rainforest Alliance certification program has resulted in the new Rainforest Alliance becoming the most influential standard setter in cocoa production [4]. This merger has promoted responsible cocoa production that is profitable for both supplier and the market [11]. In addition to requiring producers to adhere to certain agricultural practices and societal and environmental standards, the Rainforest Alliance-UTZ also supports cocoa producers in adopting environmentally friendly agricultural practices [8,12].

Globally, the percentage of certified cocoa has grown over time, from 3% in 2009 to 6% in 2010 to 30% in 2013 [13]. Today, even more than 50%, of all the global cocoa production is grown under a certification label [14]. However, according to [8], certification in Cameroon is still in its infancy. Only 3% of the nation’s cocoa output was certified in 2016 [15], but that percentage increased to 24% in 2019 [5]. Due to the age of their plantations, their small size, fragile infrastructure, inadequate insulation, and lack of resources, smallholder cocoa growers continue to participate at extremely low rates. This is because they are unable to meet the sustainability standards set by certification systems [5].

Also, the absence of public-private partnerships in certification, producers’ organizations’ limited ability to negotiate fair contracts, and the lack of significant price differences between certified and non-certified cocoa are cited as the main barriers to the adoption of cocoa certification schemes [8]. Additionally, there is empirical evidence indicating a negative correlation between the likelihood of participating in cocoa certification programs and factors such as male gender, large household sizes, aging cocoa orchards, and high levels of specialization [15,16]. Moreover, the price and premium for certified cocoa are too modest to persuade growers to upgrade their production methods [5].

However, empirical works suggest that farmers who participate in cocoa certification programs typically have higher levels of formal education [15–17], depend on more manpower, and earn more money from the farm [16]. Additionally, growers of certified cocoa appear to benefit from access to extension services, more credit availability, and larger field sizes [17]. Participation in farmer-based groups and knowledge of various certification-related issues are favorable to the adoption of cocoa certification, whereas farm size is unfavorable [17].

Given that certification is a voluntary process, private actors, including cocoa farmers, will only embrace it if it can result in higher profits [5]. Empirical research has shown that farmers who participate in cocoa certification schemes experience higher cocoa yields, higher profit margins, and higher farm and household incomes [11,15–18]. However, the relationship between this surplus profit and certification needs to be demonstrated, as there are likely to be other factors that further impact the level of profit, such as the cooperative’s effective governance or the producers’ prior training, both of which are not necessarily related to the certification process [5].

Previous research suggests that the positive profit margin difference benefiting farmers who engage in certification schemes may stem from adherence to production standards. These standards include good agricultural practices such as soil conservation, reduced pesticide use, sanitary harvesting, fermentation, and improved seeds [15]. Additional factors contributing to this margin differential include regular training, support from technical services, guidance
from cooperatives and certification bodies, improved access to farm inputs and credit, a premium per unit of cocoa sold [11,19,20], stable and adequate prices, and increased output [20].

However, participating in cocoa certification programs can lead to higher input costs (such as fertilizers, pesticides, and labor), resulting in increased output costs and lower benefit-cost ratios [11]. Conversely, non-certified cocoa production may also incur higher unit costs [15] due to excessive pesticide and mineral fertilizer use [11,15]. As a result, there is no consensus on the financial implications of cocoa growers’ involvement in certification schemes.

Providing current evidence on the drivers and benefits of participation in cocoa certification schemes to stakeholders of major cocoa-producing countries like Cameroon is crucial. According to a study conducted by [21], cocoa cultivation currently covers approximately 600,000 hectares of arable land in Cameroon. In the 2020–2021 season, Cameroon exported over 292,000 metric tons of cocoa, ranking as the 4th largest cocoa exporter globally and the 3rd largest producer in Africa after Ghana and Côte d’Ivoire [22]. However, most of the nation’s cocoa orchards are aging, facing a decline in productivity, and losing eco-friendly practices [12]. The quality of the cocoa obtained has become a major concern among stakeholders [23].

Certification initiatives implemented by cocoa farmers have influenced the country’s cocoa-producing industry over the past few decades, but they have not yet been entirely successful at the producer level [9]. Since 2012, cocoa certification has been introduced in Cameroon to address these issues. Currently, Cameroon has three systems for certifying cocoa: Rainforest Alliance-UTZ, Organic, and Fair Trade [11]. Over the years, there has been a significant increase in the share of certified cocoa produced in the country, rising from 3% in 2016 to 24% in 2019.

The adoption of cocoa certification and its possible effects have been extensively studied and documented. Nevertheless, the majority of studies [8,9,11,13,18,19] have considered adoption of cocoa certification schemes as a dichotomous parameter with two options: certified or non-certified. Other studies consider the frequency of attendance at certification training sessions [16]. Nonetheless, it has long been acknowledged that most agricultural technology adoption involves a non-binary process and usually occurs in small, gradual steps [24]. As Brown et al. point out using a dichotomous classification of adoption may make it more difficult to comprehend how a technology fits into the context of a community.

Therefore, cocoa certification can be thought of as both a process and an outcome, as it necessitates specific criteria and norms. We therefore consider the adoption of certification schemes as a process consisting of three stages: no adoption, partial adoption, and complete adoption. The uniqueness of this research lies in being one of the first studies to conceptualize adoption as a process. It also considers the scenario of partial adoption, where farmers adhere to certification standards only on certain farm plots. The study aims to provide insights into the factors influencing the adoption of the Rainforest Alliance-UTZ cocoa certification scheme and its financial implications.

By viewing adoption as a non-binary process (no-adoption, partial adoption, and complete adoption), the study utilizes ordered logistic regression and ANOVA tests to address the following research questions (1) What is the level of adoption of the Rainforest Alliance-UTZ cocoa certification scheme?; (2) What are the driving factors behind the adoption of the cocoa certification scheme?; and (3) What are the financial implications of the various levels of adoption of the Rainforest Alliance-UTZ cocoa certification scheme? The study’s objectives are to determine the level of adoption of the Rainforest Alliance-UTZ cocoa certification scheme, identify the factors that drive the adoption of certification, and assess the impact of adoption on farm revenue and profits in Cameroon’s Centre region. The following outlines how the paper is organized: Section 2 provides literature on the drivers and stakes of farmers’
involvement in cocoa certification programs. The study’s methodologies are presented in Section 3. The findings regarding the level of adoption of cocoa certification standards, the factors that influence farmers’ adoption of the scheme, and the effects of the level of adoption on farmers’ financial performance are presented in Section 4. Section 5 concludes by summarizing the findings and their policy implications.

2. Theoretical framework: The propositions, encounters, disposition, responses framework

In the field of agriculture, the question of adopting technological innovations is crucial for farm development, especially in the cocoa sector. Several researchers have tried to conceptualize this process, viewing adoption as a response to agricultural innovation [25,26]. However, a significant gap exists in how this adoption is measured, often oversimplifying reality by categorizing producers as either adopters or non-adopters [24,27–29]. This binary approach, commonly used in adoption evaluation studies [30–32], limits a comprehensive understanding of adoption processes, overlooking the nuances and complexities of the field.

In this context, [28] introduced an innovative conceptual framework, the PRDR, to better grasp the dynamic process of adopting technological innovations, particularly on small farms (Box 1).

Box 1: Presentation of the PEDR framework by [28]

The PEDR (Propositions, Encounters, Disposition, Responses) framework which structures the process of technological change, consists of four interconnected elements. First, propositions represent the introduction of a new technology, initially perceived as an idea or image of what could be achieved. These proposals suggest new working or manufacturing methods to achieve modified results.

Encounters are the moments when members of an agricultural community learn about these propositions. This can occur through various interactions such as conversations, field demonstrations, farmer meetings, or even through social media.

Dispositions, on the other hand, result from the combination of cultural, economic, biophysical, spatial, temporal, and other factors that influence the way a proposition is perceived. These dispositions vary among individuals, shaping their view of the appropriateness and relevance of the proposal for their situation.

Finally, farmers’ responses to these propositions can be diverse, ranging from ignorance to active exploration of the new opportunities offered. This process of engaging with the proposition leads to the creation of an individual journey, during which elements of the proposition such as materials, methods, and modes of engagement in agriculture are unpacked, reassembled, adapted and configured.

Source: [28]

This article specifically focuses on the "responses" and "dispositions" components of the adoption process within the Rainforest Alliance-UTZ cocoa certification system. The "responses" component highlights the various ways in which producers react to certification, showcasing the varying levels of adoption among them. Additionally, the "dispositions"
component helps interpret these responses by examining the factors that influence individual producers’ choices when deciding whether or not to adopt the certification system. Therefore, the use of the PEDR framework in this article contributes to a detailed and nuanced analysis of the adoption process, emphasizing key aspects for understanding the financial implications of cocoa certification in the Central region of Cameroon.

3. Methodology

3.1 Study area

This research focuses on Cameroon which is the 4th largest cocoa grower and exporter in the world and 3rd in Africa. Estimates for the 2020–2021 season, suggest that Cameroon exported more than 292,000 metric tons of cocoa [22]. The National Cocoa and Coffee Board (ONCC) estimates that around 241,000 metric tonnes of dry cocoa beans were produced nationally in the 2018–19 season, of which 186,000 metric tonnes were shipped without being processed and 55,000 metric tonnes were sold to local processors [33]. This research is conducted in the Centre region of Cameroon, which is the country’s primary cocoa-producing region and accounts for nearly 50% of the country’s total cocoa production [33]. The Centre region alongside, the South, East, South-West, Littoral, North-West, and East are the only seven of Cameroon’s ten regions that grow cocoa [34]. More than 80% of the nation’s total cocoa production is produced in Cameroon’s Centre and South-West regions. The output of these regions, along with the South and the Littoral, collectively represents over 94% of the country’s overall cocoa output [33].

The Centre region production basin located between the 3rd and 6th degree of North latitude and between the 10th and 15th degree of East longitude covers an area of 68,953 km2 [15]. In 2020, the region produced 158,814.7 tons of cocoa beans with an average yield of 0.49 tons per hectare [35]. Despite the climatic changes observed in recent years, the Centre region is often characterised by a “Guinean” type of climate, with average temperatures of 25˚ C and an annual rainfall of 1500 to 2000 mm/year. This region experiences a bimodal rainfall regime allowing for two crop cycles and a staggered cropping calendar with staggered sowing and harvesting [36].

The main cocoa certification schemes encountered in the Central Cameroon region are RA and UTZ [36]. The study sites are the Mbam-Inoubou and Mbam and Kim divisions of the Centre Region. This study primarily focuses on this region due to the strong interest in certified cocoa shown by cocoa stakeholders (cocoa cooperative heads, extension agents, and exporters) operating in the area. All exporters from these divisions support farmers in groups to meet the requirements for cocoa certification. The Grand Mbam is the collective name for the divisions of the Mbam-Inoubou, and Mbam and Kim. It is situated between 4˚ and 6˚ latitudes North and 10˚ and 12˚ longitudes East in the centre of Cameroon. It has a surface area of 34,600 km2, an average annual temperature of 24˚C, and a predominance of agriculture as the primary source of revenue.

3.2 Data collection

The fieldwork was completed between March and May 2022 in the Mbam and Inoubou and Mbam and Kim divisions in Cameroon’s central region. Of the fourteen subdivisions that make up the Mbam, ten were the subject of the study. A multi-stage sampling method was used to select farmers for the survey. At the first stage, the Mbam and Inoubou as well as Mbam and Kim divisions were selected due to their significant importance as major production basins in the Centre Region of Cameroon. At the second stage, the districts of Makenene, Deuck, Ndikinimeki, Kon-Yembetta, Bafia, Bokito, and Ombessa were deliberately chosen
within the Mbam and Inoubou division. Additionally, Ngoro, Ntui, and Mbangassina were specifically selected within the Mbam and Kim division. These choices were motivated by the increasing desire of cocoa farmers to enhance their cocoa plantations in these identified relevant regions as revealed by the agricultural extension agents of the area. At the third stage, ten cocoa farmers were randomly selected from each of the chosen subdivisions.

This approach resulted in the selection of a total of 100 cocoa farmers, with 70 coming from the Mbam and Inoubou division, and 30 from the Mbam and Kim division as presented in Table 1. Ten cocoa farmers were selected in each district due to the relative size of each subdivision and to ensure a balanced representation of the different geographical areas studied. The sample size of 100 cocoa farmers was determined considering practical considerations, geographical diversity, and available resources. This sample size aimed to allow for statistically significant exploration of emerging trends within the targeted population.

A semi-structured questionnaire was used to explore various aspects, including the personal characteristics of cocoa farmers and their farms, cocoa production practices, the adoption level of the Rainforest Alliance-UTZ certification scheme, and financial performance indicators. The interviews were carried out in person by two of the authors to ensure clear questioning, respondent understanding, and high-quality data collection. All interviewees were consulted prior to their interviews, informed consent was obtained from all participants and survey items were anonymised.

### 3.3 Data analysis

This study primarily assesses the implications of cocoa growers’ level of implementation of Rainforest Alliance-UTZ certification requirements on farm financial performance. A farmer can either be an “adopter” or a “non-adopter,” according to the dichotomous or binary classifications used in the majority of the studies currently available on innovation adoption [24]. The adoption of cocoa certification mechanisms, however, is seen in this research as a process where farmers gradually modify their production methods to comply with the certification schemes’ requirements, or they apply the certification standards to some but not all farm plots. [24] posit that partial adoption is rarely acknowledged or quantified in the literature. Thus, this research stands out as one of the few that includes partial adoption in its analysis.

Within the framework of this study, non-adopters are farmers who operate under the traditional system. This includes practices such as employing underage workers in their orchards, using prohibited pesticides, failing to provide employment contracts to workers, not meeting

<table>
<thead>
<tr>
<th>Division</th>
<th>Sub-division</th>
<th>Number of farmers</th>
</tr>
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<tbody>
<tr>
<td>Mbam-Inoubou</td>
<td>Makenene</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Deuck</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ndikinimeki</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Kon-Yambetta</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Bafia</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Bokito</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ombessa</td>
<td>10</td>
</tr>
<tr>
<td>Mbam and Kim</td>
<td>Ngoro</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ntui</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Mbangassina</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

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the minimum tree requirements (a minimum of 18 trees per hectare), and other practices that do not align with certification standards. Partial adopters, on the other hand, are cocoa growers who initially followed certification standards and were certified, but later acquired or established additional farm plots where they operate under the traditional production system. Complete adopters, however, are farms that strictly adhere to the Rainforest Alliance/UTZ certification standards. They implement these standards across all their cocoa orchards and officially hold certification status.

With the prevalence of Rainforest Alliance-UTZ certification being determined, an ordered logit regression was used to examine what affects growers’ levels of adoption of voluntary cocoa certification schemes. Additionally, the ANOVA test and the Tukey test were used to explore whether there are differences in producers’ financial performance with regards to the level of adoption of the cocoa certification scheme.

3.3.1 The Ordered logit model. A dichotomous approach to empirical analysis has primarily been used in quantitative studies on farmers’ readiness to adopt certification and the factors affecting the adoption of certification [9,17]. However, the dichotomous approach which is associated with the binary logistic model is inappropriate for variables with more than two outcomes. An extension of the binary logistic regression called the ordered logistic regression is appropriate when the dependent variable is categorical, has more than two modalities or degrees, and has a significant value [37].

The main advantage of the ordered logit model over the binary logit model is that the binary logit model cannot provide estimates when the explained variable has more than 2 possible outcomes. Additionally, the ordered logit model assume that the order of responses of the dependent variable is known but the distance between categories is not [38]. This feature is not present in binary logit models. Therefore, to determine the factors influencing the degree of adoption of the Rainforest Alliance-UTZ cocoa certification scheme, this research employs the ordered logistic model. Adoption is considered a course of action with three modalities: "No adoption," "Partial adoption," and "Complete adoption".

The ordered logit model, in which the outcomes’ log odds are modeled as a linear combination of the predictor variables, is appropriate for estimating the likelihood of each categorical result from more than two discrete choices [39]. Various ordered logistic regression models, including the proportionate odds model, the generalized order model, the continuation ratio, the adjacent category model, and the partial adjacent category model, are described in the literature [40].

However, consistent with [38,41,42], this study uses the partial probability ordered logit model, a variant of the generalised ordered logit model (GOL), because it offers a significantly better fit to the data than the ordered logit model and is also more cautious than other options, potentially producing results which are error-free and simple to comprehend [43]. The ordered logit model’s parallel-lines assumption is not violated by the generalised ordered model [43,44], since it relaxes the proportionality restriction and compares the likelihood of being at or below a specific point to the chance of being above that point, i.e., \( pr[y \leq m]/pr[y > m] \) [40].

Following [44], the GOL model can be written as follows:

\[
p(Y_i < j) = \frac{\exp(\beta_j' X_i)}{1 + \exp(\beta_j' X_i)}, j = 1, 2, \ldots, M - 1
\]
From the above, the probabilities that the dependent variable \(Y\) will take on each of the values \(1, \ldots, M\) are given as:

\[
P(Y_i = 1) = 1 - g(X, \beta_i) \tag{2}
\]

\[
P(Y_i = j) = g(X, \beta_{j-1}) - g(X, \beta_i), j = 2, \ldots, M - 1 \tag{3}
\]

\[
P(Y_i = M) = g(X, \beta_{M-1}) \tag{4}
\]

Here, \(Y\) is the ordinal outcome (or dependent) variable and has \(M\) categories. When \(M = 2\), the GOL model is the standard binary logit model. When \(M > 2\), the generalized ordered logit model is equivalent to a series of binary logistic regressions with the combined categories of the dependent variable [44]. Given that the dependent variable in our model is the level of adoption of the cocoa certification scheme, the GOL model will estimate two equations simultaneously and produce two sets of coefficients. Hence, with \(M = 3\), for \(j = 1\) (No adoption), category 1 (no adoption) is contrasted with categories 2 and 3 (partial and complete adoption); for \(j = 2\), the contrast is between categories 1 and 2 (No adoption and partial adoption) versus 3 (complete adoption). We can then interpret the GOL model as a series of binary logit models.

### 3.3.2 Financial performance estimations

The financial performance of cocoa farmers was evaluated per hectare of the cocoa orchard during the 2021–2022 cocoa production campaign through the cost of production, revenue from cocoa sales, other farm earnings, total farm revenue, net profit, and the benefit-cost ratio. In line with [9], the total cost of production was obtained by considering the sum of all expenditures in inputs, labour, and the annual cost of equipment (annual depreciation). Following [11], the total cost of production was calculated according to the following formula:

\[
TC = DeprC + CPest + CFert + Clab + Ccert + TranCoop + TranMkt + Oexp \tag{5}
\]

Where: \(TC\): total cost; \(DeprC\): depreciation charges; \(CPest\): cost of pesticides applied; \(CFert\): cost of fertiliser applied; \(Clab\): labour cost; \(Ccert\): cost of certification training; \(Trancoop\): transport cost of cocoa to cooperative; \(TranMkt\): fruit transport cost to local market; and \(Oexp\): other production expenses.

The total revenue was estimated as the sum of revenue from sales of cocoa, the premium paid to farmers producing certified cocoa, revenue from the sale of fruit tree products integrated into the cocoa farms and other farm revenues. The revenue from sales of cocoa was calculated as the product of the quantity of cocoa beans sold and the unit price of cocoa (the standard price for non-certified cocoa and the price with a 40–50 F CFA premium for certified cocoa). Hence, the total revenue was computed as follows:

\[
TR = CocRev + RevPr + OFRev \tag{6}
\]

\(TR\): total revenue; \(CocRev\): revenue from the sales of cocoa beans; \(RevPr\): revenue from certification premium; and \(OFRev\): other farm revenue, including revenue from the sales of fruit tree products integrated into the cocoa farms.

Profit was computed by subtracting total cost (Eq 5) from total revenue (Eq 6) as follows:

\[
\pi = TR - TC \tag{7}
\]
The BCR is the ratio of discounted benefits to discounted costs of cocoa and associated fruit tree species, expressed as:

\[ BCR = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}} \]  \hspace{1cm} (8)

Where \( t \) represents time (1 year), \( i \) stands for the discount rate (18%), \( B_t \) and \( C_t \) represent the benefits and costs respectively.

For analysis purposes, all cost and revenue components, as well as the profit margin and benefit cost ratio, were estimated per hectare of cocoa orchard in USD using an exchange rate of 1 USD = 624 FCFA (average exchange rate between USD and FCFA in 2022).

3.3.3 Effects of Rainforest Alliance-UTZ cocoa certification scheme adoption on financial performance. To uncover the financial implications of the level of adoption of the cocoa certification scheme, the one-way ANOVA test is used. The one-way ANOVA is chosen because it makes it possible to test the null hypothesis (Ho), stating that the means of three or more populations are equal, compared to the alternative hypothesis (Ha), that at least one mean is different. Thus, the one-way ANOVA tests whether the mean of the studied quantitative variable (the financial performance of cocoa farmers) is the same across the different values of the qualitative variable (the level of adoption of the certification scheme). Here, the null hypothesis highlights the equality of the means (the level of adoption has no effect on the financial performance), while the alternative hypothesis holds that an average is significantly different from the others.

The ANOVA test only reveals if some of the group means are different but says nothing about the pairs of groups in question. Hence, in line with [45], in order to identify the adoption level that matters the most for farmers financial performance and ascertain if there is a significant difference between the means of the pairs of groups, the method of Tukey was employed. Therefore, Tukey’s test is used for post-hoc analysis.

4. Results
4.1. Descriptive results
According to the findings presented in Table 2, 94% of cocoa farmers are men. The estimated mean ages of the farmer and the cocoa orchard are 53.32 years and 25.1 years, respectively. Additionally, the average cocoa farmer’s experience is 26.02 years, and 95% of farmers have received formal education compared to 5% who had no formal schooling. As per the results contained in Table 2, 72% of cocoa farmers studied are affiliated with producer’s organisations, 33% have not adopted cocoa certification, 17% have partially adopted it, and 50% have completely adopted the Rainforest Alliance/UTZ certification scheme. Therefore, the popularity of the Rainforest Alliance/UTZ cocoa certification scheme is gradually gaining ground in the Centre region. The results contained in Table 2 also show that the mean farm size is 6.356 ha with an average density of approximately 1134 cocoa trees per ha, and 95% of cocoa farmers produce under the agroforestry system. Specifically, 91%, 56%, 25%, and 13% have introduced avocado, orange, mango, and oil palm trees into their orchards.

The performance indicators show that the average cocoa yield is 583 kg/ha with a mean production cost of about 260 USD/ha. Additionally, the farmers earn on average about 970 USD/ha from the sale of cocoa and close to 63 USD/ha from the sale of Non-cocoa farm produce. The average total farm earning stands at 1013.87 USD/ha, with an average net profit of 754 USD/ha and a mean benefit cost ratio of 4.19/ha.
4.2 Factors explaining the adoption of Rainforest Alliance-UTZ Cocoa certification scheme

The estimated ordered logit model (Table 3) shows statistically significant variables influencing the level of adoption of the Rainforest Alliance-UTZ cocoa certification scheme. The model fits the data well, with a chi-squared value of 134.47 (Prob > chi2 = 0.0000). The results are presented in two panels: the first panel contrasts no adoption to partial and complete adoption (Adoption > 0), while the second panel contrasts complete adoption to no and partial adoption (Adoption > 1). Consistent with previous studies [38,43], the results of the model are interpreted as a series of binary logit models.

In the first panel, the results indicate that the practice of cocoa-based agroforestry with mango and oil palm reduces the odds of having partial or complete adoption. On the other hand, the association of cocoa-based agroforestry with orange fruit trees increases the odds of
The second panel explores the potential determinants of complete adoption of Rainforest Alliance-UTZ cocoa certification schemes, contrasting complete adoption to no and partial adoption (Adoption > 1). The findings suggest that higher plant densities per hectare reduce the log odds of having complete adoption. On the other hand, the farmer’s age and level of schooling favour complete adoption of the Rainforest Alliance-UTZ cocoa certification schemes. The findings indicate that an increase in a farmer’s age raises the odds in favour of complete adoption relative to non-adoption and partial adoption by 1.19 and 18.5 respectively.

### 4.3 Rainforest Alliance-UTZ cocoa certification scheme adoption and financial performance

In addition to identifying the drivers of the Rainforest Alliance-UTZ Cocoa Certification Scheme, this study uncovers the financial implications of the scheme. The one-way ANOVA in Table 4 presents results that allow us to determine whether financial performance depends on the level of adoption of the certification scheme. The purpose of the test is to establish if the average financial performance is consistent across all levels of adoption. The results of the test indicate that cocoa farmers’ financial performance is indeed linked to the level of adoption of the Rainforest Alliance-UTZ certification scheme.

Hence, the production cost, revenue from cocoa sales, other farm earnings, total farm earnings, net farm profit, and benefit cost ratio significantly vary on average with the level of adoption of the Rainforest Alliance-UTZ cocoa certification scheme. However, the One-way

| Table 3. Generalised ordered logit estimation results for factors affecting adoption level. |
|---------------------------------------------|---------------------------------------------|
| Level of Adoption (0 = No adoption (Q1); 1 = partial adoption (Q2), 2 = Complete adoption (Q3)) | Q1 Vs Q2-Q3 (Adoption >0) | Q1-Q2 vs Q3 (Adoption >1) |
| Variables | Odd ratio | Odd ratio |
| Association with mango (0 = No, 1 = Yes) | 0.0046* (0.013) | 0.175 (0.227) |
| Association with oranges (0 = No, 1 = Yes) | 372.93* (1196.9) | 1.503 (1.255) |
| Association with Oil palm (0 = No, 1 = Yes) | 1.84e-06** (9.70e-06) | 0.693 (1.208) |
| Association with Avocado (0 = No, 1 = Yes) | 0.0003 (0.0025) | 4.362 (5.446) |
| Age | 0.526*** (0.138) | 1.193*** (0.073) |
| Experience in cocoa production | 1.382** (0.217) | 0.985 (0.0441) |
| Surface cultivated | 1.491* (0.327) | 0.983 (0.8137) |
| Plant density per ha | 1.111 (0.0771) | 0.971** (0.0122) |
| Level of schooling (1 = university, 0 = otherwise) | 171.072 (488154.1) | 18.503* (30.53) |

Number of observations 100

Model chi2(18) 134.47

Prob > chi2 0.0000

Pseudo R2 0.6680

Log Likelihood -33.420801

Standard errors in parentheses

*** p<0.01

** p<0.05

* p<0.1

https://doi.org/10.1371/journal.pstr.0000115.t003
ANOVA only shows that some group means differ, without providing information about the specific pairs of groups in question. The Tukey’s test is utilized for post-hoc analysis to identify pairs of groups (adoption level) with mean differences in terms in financial performance. The results, as shown in Table 5, highlight significant disparities in overall farm expenses between partial adopters and non-adopters as well as between complete adopters and partial adopters.

The findings indicate that production expenses are significantly higher for partial adopters compared to non-adopters, but significantly lower for complete adopters compared to partial adopters. Therefore, partial adoption is associated with higher production expenses compared to non-adoption or complete adoption. The results also show a positive and statistically significant difference in average revenue from cocoa sales between partial adopters and non-adopters (467.53 USD/ha) and between complete adopters and non-adopters (318.96 USD/ha). Regarding non-cocoa farm earnings, the results in Table 5 suggest a positive and significant difference in average non-cocoa farm earnings between complete adopters and non-adopters (42.25 USD/ha) and between complete adopters and partial adopters (51.50 USD/ha).

Additionally, Tukey’s test results reveal no significant difference in overall farm earnings between partial and complete adopters. However, there is a positive and statistically significant difference in average overall earnings between partial adopters and non-adopters (472.41 USD/ha) and complete adopters and non-adopters (350.67 USD/ha). The mean differences in net profits between partial adopters and non-adopters and between complete adopters and partial adopters are not statistically significant. Yet, the mean difference in net profits between complete adopters and non-adopters (298 USD/ha) is statistically significant, indicating that complete adopters earn higher net farm profits on average compared to non-adopters.

Moreover, based on the results in Table 5, the mean difference in the benefit-cost ratio between complete adopters and non-adopters (1.54 per ha) and between complete adopters and partial adopters (3.12 per ha) appears to be significant. Therefore, there is a noticeable difference in the benefit-cost ratio between partial adopters and non-adopters, as well as between complete adopters and non-adopters.

5. Discussions

5.1 Descriptive Analysis of cocoa growers and the level of Adoption of cocoa certification scheme

According to the findings presented in Table 2, 94% of cocoa farmers are men, indicating that cocoa production is predominantly carried out by males, which aligns with previous studies [16,46]. The data also reveals that 72% of cocoa farmers surveyed are members of producer’s
organizations, while 33% have not adopted cocoa certification, 17% have partially adopted it, and 50% have fully embraced the Rainforest Alliance/UTZ certification program. This suggests that the Rainforest Alliance/UTZ cocoa certification is becoming increasingly popular in the Centre region. Performance indicators show that the average cocoa yield is 583 kg/ha with a production cost of approximately 260 USD/ha. These results differ from those of [46] and [21] which reported average cocoa yields of around 400 kg/ha.

### 5.2 Determinants of adoption of the Rainforest Alliance/UTZ certification scheme

The results obtained reveal significant factors influencing the adoption of the Rainforest Alliance-UTZ certification system in the Central region of Cameroon. The first panel focuses on contrasting the absence of adoption with partial and complete adoption, highlighting cocoa-based agroforestry integrating fruit trees as a key element. However, the negative influence of cocoa-based agroforestry with mango trees and oil palms on partial or full adoption contrasts with the positive impact of the association with orange trees. These results support previous studies [11,16] emphasizing the importance of carefully selecting tree species to maximize adoption.

Additionally, the negative correlation between farmer age and partial or full adoption suggests that younger farmers are more inclined to adopt certifications, a trend seen in other regions as well [5]. The results also indicate that farm size and experience in cocoa farming favor adoption, aligning with the findings of [5]. This suggests that smallholders in Cameroon may face constraints in adopting due to their smaller farm sizes, which limit their ability to introduce fruit trees as required by certification standards. These results differ from [17], who

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Adoption Levels</th>
<th>Contrast</th>
<th>Tukey Standard Error</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total production cost (USD/ha)</td>
<td>Partial adoption vs. No adoption</td>
<td>351.5204***</td>
<td>62.8562</td>
<td>5.59</td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. No adoption</td>
<td>52.6057</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. Partial adoption</td>
<td>-298.9166***</td>
<td>59.5511</td>
<td>-5.02</td>
</tr>
<tr>
<td>Revenue from cocoa sales (USD/ha)</td>
<td>Partial adoption vs. No adoption</td>
<td>467.5272***</td>
<td>149.2704</td>
<td>3.13</td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. No adoption</td>
<td>318.9591**</td>
<td>109.4469</td>
<td>2.91</td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. Partial adoption</td>
<td>-148.5682</td>
<td>141.4214</td>
<td>-1.05</td>
</tr>
<tr>
<td>Non-cocoa farm earnings (USD/ha)</td>
<td>Partial adoption vs. No adoption</td>
<td>-9.2556</td>
<td>27.0412</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. No adoption</td>
<td>42.2489**</td>
<td>19.827</td>
<td>2.13</td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. Partial adoption</td>
<td>51.5045**</td>
<td>25.619</td>
<td>2.01</td>
</tr>
<tr>
<td>Total farm earnings (USD/ha)</td>
<td>Partial adoption vs. No adoption</td>
<td>472.4119***</td>
<td>160.677</td>
<td>2.94</td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. No adoption</td>
<td>350.6688***</td>
<td>117.811</td>
<td>2.98</td>
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<tr>
<td></td>
<td>Complete adoption vs. Partial adoption</td>
<td>-121.743</td>
<td>152.2889</td>
<td>-0.80</td>
</tr>
<tr>
<td>Profit (USD/ha)</td>
<td>Partial adoption vs. No adoption</td>
<td>120.8915</td>
<td>142.6416</td>
<td>0.85</td>
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<tr>
<td></td>
<td>Complete adoption vs. No adoption</td>
<td>298.065***</td>
<td>104.5866</td>
<td>2.85</td>
</tr>
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<td>Complete adoption vs. Partial adoption</td>
<td>177.1735</td>
<td>135.1412</td>
<td>1.31</td>
</tr>
<tr>
<td>Benefit-cost ratio per ha</td>
<td>Partial adoption vs. No adoption</td>
<td>-1.5814</td>
<td>1.269</td>
<td>-1.25</td>
</tr>
<tr>
<td></td>
<td>Complete adoption vs. No adoption</td>
<td>1.5373*</td>
<td>0.9345</td>
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<td></td>
<td>Complete adoption vs. Partial adoption</td>
<td>3.1188**</td>
<td>1.1967</td>
<td>2.61</td>
</tr>
</tbody>
</table>

*** p<0.01
** p<0.05
* p<0.1

https://doi.org/10.1371/journal.pstr.0000115.t005
found resistance to cocoa certification among smallholders in the Ashanti region of Ghana, underscoring the need to consider contextual factors.

In the second panel, higher plant densities per hectare are associated with reduced odds of complete adoption. This may be because the certification scheme mandates a minimum of 18 trees per hectare in cocoa agroforestry systems, so increasing plant density could make it challenging to meet this requirement and comply with certification norms.

On the other hand, the farmer’s age, and level of schooling favour complete adoption of the Rainforest Alliance-UTZ cocoa certification schemes. The findings indicate that an increase in a farmer’s age raises the odds of complete adoption. This result could be connected to the fact that agriculture in general and cocoa production in particular, are mostly practiced by the elderly, as evidenced by the average age of about 53 years (Table 2). They are therefore likely to adopt technologies and innovations with the potential to boost their yields and earnings, since they mostly rely on agriculture as their main occupation and main source of income.

The positive contribution of higher levels of schooling could be due to education helping farmers acquire the competencies offered by training and certification programs. Highly educated farmers also have the potential to quickly understand the importance and potential gains of innovations such as certification schemes. This result is in line with those of [15–17], who all suggest that farmers who participate in cocoa certification programs typically have higher levels of formal education.

5.3 Effects of certification on financial performance

The results of this study emphasize important nuances regarding the financial performance of farmers in relation to their adoption level of certification. When it comes to production expenditures, partial adopters exhibit significantly higher expenses than non-adopters, while complete adopters demonstrate significantly reduced costs compared to partial adopters. This difference could be attributed to complete adopters strictly adhering to certification standards, which mandate the implementation of good agricultural practices and a decrease in the use of expensive inputs. On the other hand, partial adopters, although dedicated to certification, may not fully comply with all requirements, leading to increased production costs. Furthermore, non-certified cocoa orchards may experience excessive use of pesticides and mineral fertilizers, as noted by [11] and [15], potentially resulting in suboptimal production methods and escalating costs for partial adopters.

The results in Table 5 show a positive and significant difference in average revenue from cocoa sales between partial adopters and non-adopters, as well as between complete adopters and non-adopters. The difference may be attributed to the premium earned per unit of certified cocoa sold and the steady and sufficient prices earned per unit of certified cocoa sold and the consistent prices received by certified cocoa farmers as noted by [11,19,20]. In terms of non-cocoa farm earnings, there is a positive and significant difference between the average non-cocoa farm earnings of complete adopters and non-adopters, as well as between complete adopters and partial adopters. This result could be due to the requirement of complete adoption for farmers to grow cocoa in an agroforestry system with at least 18 trees per hectare, as mandated by the Rainforest Alliance-UTZ certification scheme, giving them with an opportunity to generate substantial income from non-cocoa farm produce sales.

The results in Table 5 indicate a positive and statistically significant difference in average overall earnings between partial adopters and non-adopters, as well as between complete adopters and non-adopters. This is in line with [16], who suggest that the additional income from premium payments by certified farmers could explain this result. Furthermore, the positive farm earning gap observed in complete adopters may be attributed to their adherence to
certification standards through practicing good agricultural techniques such as soil conservation, reduced pesticide use, proper harvesting, fermentation, and use of improved seeds, as mentioned by [15]. Additionally, [47] found that Fair Trade-certified producers do receive higher prices than conventional farmers for their products.

Therefore, complete adopters, on average, earn higher net farm profits relative to non-adopters. These results align with previous studies [11,15–18], which revealed that farmers participating in cocoa certification programs experience higher profit margins and increased farm and household incomes. Additionally, these findings are supported by [5], who found a positive association in Cameroon between a cocoa farmer’s participation in the certification process and the average level of profit.

Hence, there is a significant difference in the benefit-cost ratio between partial adopters and non-adopters, as well as between complete adopters and non-adopters. This result contradicts the findings of [11], who claimed that participation in cocoa certification programs leads to higher input costs (fertilizer, pesticides, and labor), increased output costs, and lower benefit-cost ratios. However, this contradiction could be explained by the support that certified cocoa producers receive, such as regular training, guidance from technical services, advice from cooperatives and certification bodies, increased access to farm inputs, and credit, as suggested by [19].

In summary, these results emphasize the importance of fully adopting certification to enhance farmers’ financial performance. The premiums received, stable prices, reduced production expenses, and higher profit margins demonstrate the concrete economic benefits associated with this practice. The policy and practical implications of this study are crucial for policymakers and practitioners in the cocoa sector in major cocoa-producing nations. Active promotion of Rainforest Alliance-UTZ certification can be strengthened by highlighting the significant financial benefits seen among full adopters. Financial incentives, such as subsidies or tax holidays, could play a vital role in encouraging farmers to embrace these sustainable practices [19].

Based on these results, several recommendations emerge to build a more sustainable and resilient cocoa sector. Firstly, cocoa growers are encouraged to fully adhere to Rainforest Alliance-UTZ certification standards to earn substantial financial gains, improve their livelihoods, and produce with environmentally friendly practices. Growers in the partial adoption category should also follow certification norms and apply them to all their farms to minimize production expenses and increase farm earnings. Additionally, cocoa certification promotion bodies and extension agents should focus on introducing fruit trees, such as orange trees, in cocoa orchards, as they are positively correlated with higher adoption levels. Efforts to disseminate cocoa certification schemes should target farmers with lower educational attainment, as they are less likely to adopt certification standards.

6. Conclusion

The paper has empirically assessed the level of adoption of the Rainforest Alliance-UTZ cocoa certification scheme, its drivers, and its financial fallouts. The study concludes that the adoption of cocoa certification schemes is on the rise in the Centre Region of Cameroon. Overall, cocoa agroforestry-based systems with mango (*Mangifera indica*), oranges (*Citrus sinensis*), and oil palm (*Elaeis guineensis*), the farmer’s age, experience in cocoa production, size of the orchard, and level of schooling significantly affect the farmer’s level of adoption of the Rainforest Alliance-UTZ certification scheme. The study also concludes that cocoa growers’ financial performance varies with the level of adoption of the Rainforest Alliance-UTZ certification scheme and that complete adoption offers farmers higher farm earnings. In summary, the
study highlights the importance of complete adoption of certification schemes by cocoa growers as it has the potential to boost their earnings, improve their livelihoods, and minimize the environmental impact of their activities.

**Supporting information**

S1 Dataset. Survey data on Cocoa certification in the Centre region Cameroon_Dataset. (XLSX)

**Author Contributions**

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**Methodology:** Hubert N. T. Takam.

**Writing – original draft:** Boris D. Soh Wenda, Hugues Nken, Christian E. Eloundou.

**Writing – review & editing:** Hubert N. T. Takam, Dorothy E. Fon.

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