

Weighing benefits in cocoa farming systems: An analysis of profitability in certified and non-certified cocoa farming schemes in Cameroon

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Abstract

The environmental and economic benefits of certified cocoa production are well documented in the current literature. Yet, adoption rates remain largely suboptimal, at least partially due to insufficiently documented empirical evidence on comparative advantage of certified cocoa schemes over conventional production systems. This study estimates profits in certified and non-certified cocoa farming systems in Meme Division in Cameroon. Mixed methods research design and the multistage sampling technique were applied to collect and analyse data, and comparatively estimate profits by applying the gross margins (GM), net farm income (NFI), net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR) analyses on 460 individual cocoa farmers. The results showed that GM, NFI, NPV and BCR were significantly higher for certified cocoa farmers compared to non-certified cocoa farmers ($p=0.000$). The study concludes that certified cocoa production is more profitable than non-certified cocoa production, and therefore has a significant positive impact on the livelihoods of those involved. It is recommended that farmers in the study area be encouraged to adopt certified cocoa production, for example by facilitating access to relevant resources for certified cocoa production, such as access to credit and other policies and programmes designed to motivate participation.

Keywords: benefits, farming systems, profitability, *Theobroma cacao*

1 Introduction

Many developing economies are largely agrarian, with agricultural production largely driven by smallholder and subsistence agricultural systems. Agriculture contributes about 35 % to Africa's Gross National Product (GDP), and up to 40 % for sub-Saharan Africa (SSA) (FAO, 2020; USAID, 2023). Over 60 % of the population and 85 % of the rural population in SSA depends on agriculture for livelihoods (FAO, 2020; USAID, 2023). Evidently, cocoa (*Theobroma cacao*) and coffee (*Coffea spp*) are the leading export crops from Africa, contributing to employment and GDP (Tham-Agyekum *et al.*, 2024). The cocoa sector employs an estimated 4.5 million people in Africa and contributes the greatest share of agriculture's contribution to GNP, when compared with other crops (Hütz-Adams *et al.*, 2016). In Cameroon for instance, the cocoa value chain generated a total added value of € 400 million, contributing 1.2 % to her GDP in 2021. This constituted 8.2 % of agriculture's 17 % contribution to the GDP, that is, over 48 % (ELORM, 2022).

Cocoa is a tropical crop, grown mainly in West Africa and Southern America. SSA accounted for about 73.6 % of the global production for the 2020/2021 cocoa season, which stood at 4,005,000 tonnes (ICCO, 2021). Cocoa farming provides great support to livelihoods, mainly through job creation and income generation (Vivek *et al.*, 2019; Tridge, 2021; Cocoa Net, 2022). Despite its great potential, cocoa farming still faces a number of challenges (such as ageing farms and poor organisation of the sector) that contribute the impoverishment of cocoa farmers (Wilson & Lovell, 2016), and the application of unsustainable practices. In fact, the drive for immediate cash pushes many farmers to engage in cocoa production at the expense of environmental protection (Wilson & Lovell, 2016). This has led to cocoa certification by leading European companies (Skalidou, 2018).

According to Ingram *et al.* (2018), the objective of cocoa certification is to ensure that marketed cocoa respects some compliance standards, including social aspects such as prohibition of child labour on cocoa farms and freedom of association; environmental sustainability including improved soil conservation practices, limited or non-use of pesticides

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and inorganic fertilisers, protection of water sources, proper waste management, and non-use of genetically modified organisms; and economic standards, particularly product traceability and a fair premium for certified cocoa. The certification process therefore ensures and authenticates that what consumers buy has been produced in a sustainable way (Skalidou, 2018; Fountain & Hütz-Adams, 2020). Apparently, cocoa certification may create more profitable supply lines thus incentivising its adoption (Joseph & Adewale, 2013). However, adoption of certified cocoa farming remains slow, in spite of its market potential and environmental benefits (Abei & Van Rooyen, 2018).

Like many other sub-Saharan African Countries, agriculture is the backbone of Cameroon's economy (Bomdzele & Molua, 2023), employing an estimated 70 % of its population, and accounting for about 33.3 % of the country's earnings (Akumbom *et al.*, 2023). The Cocoa sector alone contributes 1.2 % to Cameroon's GDP, accounts for 8.2 % of agricultural GDP, and creates over 400,000 jobs (O'Neill, 2023). According to OEC (2020), in Cameroon, cocoa is ranked the second top export commodity, which contributed about US \$ 403 million, representing 14.8 % of total exports, after crude petroleum for 29.8 % in 2017. It is argued that a shift from non-certified to certified cocoa farming schemes is essential to ensure financial and environmental sustainability in the cocoa sector (Ansah *et al.*, 2020 ; Rainforest Alliance, 2021).

Two types of cocoa beans are produced in Cameroon, namely ordinary (non-certified) and certified cocoa beans. Non-certified cocoa beans are usually purple in colour, heterogeneous in size, generally has foreign materials and infested by disease; while certified has a humidity content of ≤ 7.5 % minimum infection from pest and disease, fewer defects on grains, minimal moldiness, homogeneous grains, and less foreign matter (Ansah *et al.*, 2020 ; Rainforest Alliance, 2021).

While it is clear that cocoa certification is gaining ground, adoption in Cameroon is still low. According to the Rainforest Alliance (2021), only 42,394 tonnes (14.3 %) of the total cocoa production in Cameroon was sold under certification schemes for the 2019/2020 season. Cameroon is the fourth largest cocoa producing country in the world and third largest in Africa (O'Neil, 2023). It has the ambition to increase production from the current 295,028 tonnes to 640,000 tonnes per year by 2030. A shift towards certification holds great potential for cocoa farmers, such as increased yields, higher profits and net incomes, and an overall improvement in livelihoods (Tham-Agyekum *et al.*, 2024); and for Cameroon's economy, particularly cocoa's contribution to the agricultural GDP.

Although certification results in attractive selling price (premium price) for certified cocoa, it entails additional cost such as training, farm audits, and certification fees (Skalidou, 2018; Jaza *et al.* 2021). The concept of certified cocoa production was introduced in Cameroon in 2012 with the aim to record both qualitative and quantitative improvements of cocoa produced (Jaza *et al.* 2021). Since the introduction of the concept, adoption rates are considered low, as only about 14 % of certified cocoa was sold nationally during 2019/2020 cocoa season in Cameroon (Rainforest Alliance, 2021). This implies that conventional cocoa production is still dominating despite the social, environmental and economic advantages of certified cocoa production. Building from a purely capitalist perspective of the goal of business, which is profit maximisation, this study attempts an analysis of profitability in cocoa farming, comparing certified and non-certified farming schemes in Meme Division, the most important cocoa production basin in Cameroon.

2 Materials and methods

This study employs a mixed methods research design for cross sectional data collection. This included the use of questionnaires and focus group discussions to survey the cocoa production zone of Meme in the South-West region to collect data. Based on MINADER (2018), and employing the statistical sample estimation technique of Taro Yamane formula (Yamane, 1973), a total of 460 respondents were sampled for the study given that Meme Division is reported to have over 98,800 cocoa producers.

The multi-stage sampling technique was utilised in the study. The first stage was the purposive selection of the South-West region, since it is the most important cocoa producing zone in Cameroon, accounting for 43.4 % of the country's total production (NCCB, 2024). Meme division in the South-West region was purposively selected because of its agrarian nature, which is dominated by subsistence farming and smallholder cocoa farms. The sub-divisions Mbongue, Kumba III and Konye out of the six sub divisions in Meme were selected because they were reported by MINADER (2018) to be the leading cocoa producers in the division, with cocoa production being the main source of income for survival. The next stage was the purposive selection of two villages each from the three subdivisions giving a total of six villages (Baduma, Ngolo bolo, Ediki, Mabanda, Malende, Kombone mission), reported to have the highest number of (certified and non-certified) cocoa farmers. Finally, random sampling technique was used to select 460 individual cocoa producers in the respective villages that constituted the sample retained for the study

partitioned with 400 responding to questionnaires and 60 providing information through focus group discussions. Randomisation of the final sample allows the results to be generalised (Winer *et al.*, 1991; Shadish *et al.*, 2001) at least for cocoa farmers in the study communities in Meme division.

Sample inclusion criteria utilised included minimum age of 25 years, minimum farm age of 5 years given that cocoa takes 3 to 5 years to mature, and minimum 5 years cocoa farming experience of the participant. These were judged by the research team as key essential criteria to ensure that data provided was rich enough to inform and satisfy the study objective. Data analysis employed the gross margin analysis (GMA), net farm income (NFI), net present value (NPV), benefit cost ratio and internal rate of return (IRR) to estimate the differences in profit levels.

The GM was estimated as the difference between the gross income (GI) or total revenue (TR) and the total variable costs (TVC). The variable cost components included land preparation, planting materials, fertiliser, agrochemicals, harvesting, labour cost and transportation. The GM value of each respondent was calculated separately before employing for final analysis. The mathematical expression of gross margin analysis is:

$$GM = TR - TVC \quad (1)$$

The TR of a certified cocoa producer (CCP) was computed by summing the sales of cocoa, other crops grown in the cocoa farm, and the premium paid. The TR of each respondent was computed separately before employing for final analysis. This implied that, for the certified cocoa farmers or producers, the TR was computed as follows:

$$TR = RC + RO + RP \quad (2)$$

Where RC = revenue from cocoa sales, RO = revenue from sales of other crops integrated in the cocoa farms, RP = premium paid to the farmer

Similarly, for non-certified cocoa producer (NCCP), the TR was computed by summing the sales of cocoa and the other associated crops the cocoa farms. This implied that, for the non-certified cocoa farmers or producers, the total revenue was computed as follows:

$$TR = RC + RO \quad (3)$$

The TVC of a certified and non-certified cocoa producer was computed by summing the cost of inputs, the cost of labour, cost of transportation, cost of fermentation and cost of drying. The value of TVC of each respondent was calculated

separately before employing for final analysis. This implied that, for the certified and non-certified cocoa producers, the total variable cost was computed as follows:

$$TVC = CI + CL + CT + CF + CD \quad (4)$$

Where CI = total cost of inputs, CL = total cost of labour, CT = cost of transportation, CF = cost of fermentation, CD = cost of drying.

The GMn of certified and non-certified cocoa production was compared using independent t-test to know which system possessed highest gross profit. The costs of items were computed by assuming the average prices paid by respondents or cocoa producers within the study area. This means that for any item or activity, an average price or cost was considered. This phenomenon was applied in all cost aspects in the study.

Net farm income (NFI) was calculated by subtracting farm production expenses from gross farm income. The value of NFI of each respondent was calculated separately before employing for final analysis. NFI considered both cash and non-cash income as well as expenses and accounts for changes in commodity inventories and was estimated as follows:

$$NFI = TR - TC \quad (5)$$

and

$$TC = TVC + TFC \quad (6)$$

The TFC of a certified cocoa farmer was computed by taking the sum depreciation of various farm equipment or materials and the cost of cocoa certification. The value of TFC of each respondent was calculated separately before employing for final analysis. This implied that, for the certified cocoa farmers or producers, TFC was computed as follows:

$$TFC = D + TCC \quad (7)$$

The TFC of a non-certified cocoa producer or farmer was computed by considering the sum depreciation of various farm equipment or materials incurred by the category of this farmer. This implied that, the TFC for the non-certified cocoa farmers or producers was computed as follows:

$$TFC = D \quad (8)$$

Where D = sum of depreciation of various farm equipment. The depreciation of each equipment was computed by dividing the value of that particular equipment by its lifespan or number of years it can be used. In this regards, farm equipment were; knapsack sprayer, oven, harvesting knife, leader, tarpaulin, fermentation basket and drum; TCC = total cost of

cocoa certification (cost of passport size photograph and the opportunity cost of labour for attaining training since other associated costs of certification were free). The NFI of certified and non-certified cocoa production was compared using independent t-test to know which system significantly possessed higher net profit.

The value of NPV of each respondent was calculated separately before employing for final analysis. NPV was calculated on the average hectare in the study area using the following expression:

$$\text{Net Present Value (NPV)} = \sum_{t=1}^n \frac{B_t - C_t}{(1+i)^t} = \text{discounted revenue} - \text{discounted cost} \quad (9)$$

Benefit cost ration was used to compare certified and non-certified cocoa production in a single term. The value of BCR of each respondent was calculated separately before for final analysis. This study estimated the Benefit Cost Ratio (BCR) as follows:

$$\text{Benefit Cost Ratio (BCR)} = \frac{\sum_{t=1}^n \frac{B_t}{(1+i)^t}}{\sum_{t=1}^n \frac{C_t}{(1+i)^t}} = \text{discounted revenue} / \text{discounted cost} \quad (10)$$

Where B_t = benefit per hectare in each year; C_t = cost of production per hectare in each year, $t = 1, 2, 3, \dots, n$, n = number of years, \sum = summation sign, i = interest rate.

Further, the internal rate of return (IRR) was used to compare certified and non-certified cocoa production to know the best option. The value of IRR of each respondent was calculated separately before employing for final analysis. The current study estimated the IRR as the lower discount rate + the differences between the discount rates.

Through focus group discussions, the interest rate was established from respondents. As mentioned, respondents borrow or loan money from cooperative credit unions, 'njangi' meetings (a type of rotating savings and credit schemes) and cocoa local buying agents. The annual interest rates for cooperative unions and 'njangi' meetings was 18% that is 1.5% monthly and that of local buying agents was 50% locally referred to as "ten-born-ten". This study adopted 18% and 50% as the annual lower and upper interest rate respectively. Thus the decision rules were that; if the IRR is greater than the discount rate, the higher the IRR the more profitable project is. This implied that the farming system (certified and non-certified farming) with higher IRR was considered more profitable.

3 Results

3.1 Demographic characteristics of the sample

The demographic results for certified and non-certified farmers are summarised in Table 1. Certified cocoa farms tend to be larger, with 75% of them being 3 ha and above, compared to only 32% of non-certified farms in this category. Interestingly, certified farmers seem to have more experience in cocoa farming than non-certified farmers. For example, 37.5% of certified farmers have more than 25 years of experience, compared to only 12.2% of non-certified farmers. Overall, 63.5% of certified cocoa farmers have more than 21 years of experience, which is 27 percentage points more than the 36.2% of non-certified farmers. The majority of farmers in both groups are over 35 years old, as less than 20% (18.3% for certified farmers and 12.2% for non-certified farmers) are between 25 and 35 years old. Larger farm sizes and experience seem to favour the adoption of certified cocoa production. However, further (qualitative) research is needed to substantiate these claims.

Table 1: Demographic characteristics of the sample.

	certified farmers (n = 104) in %	non-certified farmers (n = 296) in %
Farm size (ha)		
≤ 2	8.7	37.5
> 2 ≤ 3	19.2	30.4
> 3 ≤ 4	26.9	19.9
> 4	45.2	12.2
Years of experience in Cocoa farming		
5-10	4.8	12.2
11-15	12.5	20.3
16-20	19.2	31.3
21-25	26	24.0
>25	37.5	12.2
Age distribution of participants (years)		
25-35	18.3	12.5
36-45	35.6	28.4
46-55	31.7	35.1
>56	14.4	24.0

3.2 Estimation of production cost

To estimate production cost, we computed separately variable cost and fixed cost per hectare per year. Data was collected on the elements of cost such as cost of material or equipment (depreciation) and variable cost (labour cost and input cost). Variable cost data collection elements included

Table 2: Total variable cost per hectare per year (2022/2023 Cocoa Season) in FCFA.

Items	producers		average difference	t-value	Sig
	certified	non-certified			
Fertiliser	55,000	35,000	20,000	14.531	0.000
Pesticide	50,479	57,923	-7,443	3.399	0.000
Labour (family/hired)	49,250	35,500	21,750	4.864	0.000
Opportunity cost to attend trainings	18,000	-	18,000	51.432	0.000
Transportation (cocoa)	12,500	11,000	1,500	3.472	0.003
Transportation (others)	7,500	7,500	0	1.097	0.278
Fermentation	5,000	-	5,000	53.666	0.000
Drying	15,000	7,000	3,000	4.373	0.005
Packaging	3,000	1,000	2,000	16.879	0.000
TVC	215,729	154,923	60,807	52.78	0.000

Note: 1 Euro = 655.957 FCFA; TVC = total variable cost.

Table 3: Estimated total fixed cost per hectare per year (2022/2023 cocoa season) in FCFA.

Items	producers		average difference	t-value	Sig
	certified	non-certified			
Snap sac sprayer	6,746	6,946	200	-0.186	.854
Truck	11,000	11,903	-903	-1.883	.076
Cutlass	2,500	2,500	000	0.419	.680
Tarpaulin	13,675	12,475	200	1.883	.067
Fermentation box	2,316	-2,316	-	-	-
Harvesting knife	328	308	20	0.131	0.713
Ladder	500	440	60	0.792	.439
Registration cost	2,000	-	2,000	-	-
Drum	6,505	6,405	100	0.561	0.581
Digger	978	918	60	0.139	0.891
TFC	46,548	41,894	6,054	47.788	.000

Note: 1 Euro = 655.957 FCFA; TFC = total fixed cost.

cost of pesticides, labour cost (hired, family and permanent) and materials or equipment of lifespan less than or equal to one year. Table 2 represents the summarised results. The results in table 2 show that the total variable cost of certified cocoa producers per hectare per year is on average FCFA 215,729 and on average FCFA 154,922 for non-certified cocoa producers. The average difference in the total variable cost of FCFA 60,806 is statistically significant ($t = 52.78$ and $p = 0.000$). A statistically significant difference therefore exists in the total variable cost (TVC) between certified cocoa producers and non-certified cocoa producers. This great difference is a result of the fact that certified cocoa producers incurred other cost like training cost and fermentation cost which is absent for non-certified cocoa producers.

FC was estimated using depreciation and interest, given that cocoa farmers neither pay taxes nor insurance. The depreciation was calculated by dividing the value of each equipment owned by cocoa producers by its lifespan or number of years the equipment can stay. Also, interest on loans was calculated by multiplying the interest rate by the total money loan by cocoa producers. Table 3 represents the estimated total fixed cost of certified and non-certified cocoa producers in FCFA per hectare per year.

From table 4, the absolute value of the experimental t-value (52.78) is smaller than the degree of freedom implying that TFC is significantly different between the producers. Table 3 represents the estimated total cost (TC) incurred per hectare per year by certified and non-certified cocoa producers.

Table 4: Total cost (TC) incurred per hectare per year (2022/2023 cocoa season) in FCFA.

Items	producers		average difference	t-value	Sig
	certified	non-certified			
TVC	215,729	154,923	60,807	52.78	.000
TFC	46,548	41,894	4,654	47.79	.000
TC	262,277	196,817	65,460***	56.69	.000

Note: 1 Euro = 655.957 FCFA; TVC = total variable cost; TFC = total fixed cost; TC = total cost.

The results in Table 4 further show that the total cost (TC) per hectare per year is averagely FCFA 262,277.40 for certified cocoa producers and FCFA 196,817.23 for non-certified cocoa producers. This therefore gives an average difference in the total cost of FCFA 65,460.18. It is also observed in table 4 that t-value = 56.693 and p = 0.000 which implies a statistically significant difference in the TC between the producers. Moreover, the absolute value of the experimental t-value (52.78) is also smaller the degree of freedom implying that TC is significantly different between the producers.

3.3 Estimation of total revenue

To estimate total revenue, the sum of revenue obtained from the sale of cocoa and other crops associated in the cocoa farm (oranges, mangoes, pears, bitter cola) and the premium prices (for certified cocoa producers) was average per hectare per year. Premium price of FCFA 50 per kilogram of cocoa was also added to the revenue of certified cocoa producers. It is important to mention that the premium price was an additional benefit paid to farmers who adopted certified coffee farming as a way of suggesting that certified cocoa had more value. Table 5 represents the summarised results.

Table 5: Total cost (TC) incurred per hectare per year (2022/2023 cocoa season) in FCFA.

Sale of	producers		average difference	t-value	Sig
	certified	non-certified			
cocoa	479,760	422,289	57,471	13.359	.000
other produce*	123,790	108,500	15,290	4.465	.000
Premium price	25,250	00	25,250	-	-

Note: 1 Euro = 655.957 FCFA; TVC = total variable cost; TFC = total fixed cost; TC = total cost. *other produce associated in cocoa farms.

From Table 5, the total revenue (TR) per hectare per year is averagely FCFA 628,800 for certified cocoa producer and FCFA 537,249 for non-certified cocoa producers, hence an average difference of FCFA 91,552. It is also observed in

table 4 that t-value = 15.032 and p = 0.000, indicating a statistically significant difference in the TR between the producers. Moreover, the absolute value of the experimental t-value (15.032) further confirms the significantly difference.

3.4 Estimation of gross margins

Gross margin (GM) was estimated by subtracting the value of the average total variable cost from the average total revenue per year per hectare. That is the sum of the total revenue of each cocoa producer in each category divided by the number of respondents in each category minus the sum of total variable cost of each respondent in each category (certified and non-certified cocoa producers) divided by the number of cocoa producers or respondents found in each category per hectare per year. Table 6 represents the estimated GM of a certified and non-certified cocoa producer per hectare per year.

Table 6: Estimated gross margins per hectare per year (2022/2023 cocoa season) in FCFA.

Items	producers		average difference
	certified	non-certified	
TR	628,800	537,249	91,551
TVC	215,729	154,923	60,807
GM	413,071	382,326	30,745

Note: 1 Euro = 655.957 FCFA; TR = total revenue; TVC = total variable cost; GM = gross margin.

As seen in table 6, GM per hectare per year is FCFA 413,077 for certified cocoa producer and FCFA 382,326 for non-certified cocoa producer. This gives an average difference FCFA 30,745. Evidently, both cocoa farming systems are profitable and this may be a justification for slow adoption of certified cocoa farming.

3.5 Net farm income estimation

Net farm income (NFI) was estimated by subtracting the value of the average total cost from the average total revenue per year per hectare. That is the sum of the total revenue of each cocoa producer in each category divided by the number of respondents found in that category minus the sum of total cost of each respondent in each category divided by the number of cocoa producers or respondents found in each category per hectare per year. Table A1 in the supplement shows that the NFI per hectare per year is averagely FCFA 370,369 for certified cocoa producers and FCFA 340,432 for non-certified cocoa producers, giving an average difference in the NFI of FCFA 29,937.

3.6 Cost-benefit analysis of certified and non-certified cocoa production

This study analysed the data by using different cost-benefit analysis (CBA) methods namely NPV, BCR and IRR Net to observe the net profitability of the farms as well as the relative costs and benefits relationship. This study estimated the NPV of each category by summing the discounted revenue of all the respondents found in each category divided by the number of respondents found in each category minus the sum of the discounted revenue of all the respondents found in each category divided by the number of respondents found in each category per hectare per year. A common interest rate (18 %) was considered to estimate the discounted revenue and discounted cost for the both categories.

The results in table A2 in the supplement show that the net present value (NPV) per hectare per year for certified cocoa producers is averagely FCFA 306,386 and FCFA 283,281 for non-certified cocoa producers, with an average NPV difference of FCFA 23,105. This may be linked to the fact that higher investment generates higher income.

This study applied benefit cost ratio as an indicator showing the relationship between relative costs and benefits of the two farming types or systems (certified and non-certified) in monetary terms. Benefit cost ratio was applied because it determines the expected benefit generated by each franc spent or invested in the farm. The study estimated the benefit cost ratio (BCR) of each category by taking the average of discounted revenue of all the respondents found in each category divided by the average discounted cost of all the respondents found in each category per hectare per year and using a common interest rate (18 %).

From Table A3, the BCR per hectare per year is averagely 1.33 for certified cocoa producers and 1.22 for non-certified cocoa producers, indicating an average BCR difference of 0.11. This implies that the more the cost incurred, the more the benefit in return. Put differently, certified cocoa producers incurred higher cost than non-certified cocoa producers, consequently they also earned more benefit in return. This may attributed to the fact that the productivity of certified cocoa producers is higher than that of non-certified cocoa producers.

To estimate the internal rate of return (IRR), the lower discount rate was the average interest rate of cocoa producers per year which was 18 %, adopted from financial institutions where cocoa producers in the study area have access. Similarly, the upper discount rate was obtained from the local concept often known as “Ten-Born-Ten” which means borrowing money on 50 % interest rate. Net present value (NPV) at lower discount rate was estimated by calculating 18 % of NPV of each respondent in each group then the mean

value considered. Similarly, Net present value (NPV) at upper discount rate was estimated by calculating 50 % of NPV of each respondent in each group then the mean value considered.

The results in Table A4 in the supplement show that the IRR per hectare per is averagely 36.9 % for certified cocoa producers and 35.7 % for non-certified cocoa producers, giving an average difference of 1.2 %. This implies there is a higher tendency that certified cocoa producers pay back their loans than their counterpart non-certified cocoa producers. This may be linked to the fact capital productivity of certified cocoa farming is higher than non-certified cocoa farming.

To test the hypothesis that certified cocoa production is more profitable than non-certified cocoa production, an independent sample t-test was used to compare profit differentials by comparing their GM, NFI, NPV, BCR and IRR. The results in Table A5 in the supplement revealed that the t-value and p of GM are respectively 5.078 and 0.000, implying a statistically significant difference in the GM. This is further confirmed by the absolute value of the experimental t-value (5.078). This implied that GM of certified cocoa producers is significantly higher than that of non-certified cocoa producers with respective values FCFA 413,071 and FCFA 382,326 per ha per year.

In Table A5, it is observed that t-value and p are respectively 5.089 and 0.000, which implies that there is statistically significant difference in the NFI between producers. Moreover, the absolute value of the experimental t-value (5.098) confirms NFI of certified cocoa producers is significantly higher than that of non-certified cocoa producers with respective values FCFA 306,386 and FCFA 283,281 per ha per year.

Further, Table A5, revealed t-value = 4.307 and p = 0.000 which implies that there is statistically significant difference in the NPV between producers, with the absolute value of the experimental t-value (4.307) indicating that the NPV is significantly different with that for certified cocoa producers higher than that of their counterpart non-certified cocoa producers with respective values FCFA 303,435 and FCFA 283,693 per ha per year.

It is also observed in A5 that t-value = 11.122 and p = 0.000 which implies that there is statistically significant difference in the BCR between producers, with the absolute value of the experimental t-value (11.122) indicating that BCR of certified cocoa producers is significantly (1 %) higher than that of their counterpart non-certified cocoa producers with respective values of 1.33 and 1.22 per year.

Table A5 further shows a t-value = 592 and p = 0.554, indicating that there is no statistically significant difference in the IRR between producers. This implies that IRR of certi-

fied cocoa producers is higher than that of non-certified cocoa producers with respective values 36.9% and 35.7% per year. This may be attributed to the fact that there is higher return in benefit for capital invested in certified cocoa production than non-certified cocoa production due to higher capital productivity.

In summary, the results in table A5 revealed that GM, NFI, NPV and BCR are statistically significant at 1%. This means that the profit of the certified cocoa producer is significantly higher than that of the non-certified cocoa producers. This may be due to the fact that as farmers adopt improved farming practices (cocoa certification), their production and productivity increase, and consequently their profits increase. In addition, certified cocoa fetches a higher price due to the premium (FCFA 50 kg⁻¹ of cocoa) paid back to this group of producers.

4 Discussion

Demographic analysis suggests that larger farm sizes and experience are among key drivers for the adoption of certified cocoa production in the study area. Previous studies support our contention. For instance, Fred *et al.* (2022) identified farm experience as a key socioeconomic driver for adopting certified cocoa production in Ghana. An earlier study by Djokoto *et al.* (2016) identified farm size among other variables as a driver for switching to organic (certified) cocoa production in Ghana. As concerns farm sizes, 111 respondents practicing non-certified cocoa farming had farms of less than 2 ha while majority of those practicing certified farming had farm sizes of more than 4 hectares. Further, in both farming systems, farming experience was impressive standing at above 11 years. The farming experience couples with the ages of the respondents showed a great maturity of the study participants, suggesting a great deal of knowledge gotten through experience.

TVC results average FCFA 215,729 for certified producers and FCFA 154,923 for non-certified producers; this indicates that VC on production was higher in certified production systems. This apparently can be associated to additional costs, given that certified cocoa production attracts more activities such as fermentation and drying for longer periods which are more time and labour demanding, and charges to cooperatives which inflict additional, sometimes unknown costs (Jaza *et al.*, 2021). Further, TFC in certified production was observed to be higher by FCFA 6,054. The difference could be explained by the fact that cocoa certification recommended fermentation boxes in order to ferment fresh cocoa beans and registration requirements like passport size photographs, training associated cost. These findings

are however contrary to those of Jaza *et al.* (2021) where they found out that there is no cost difference between certified and non-certified cocoa producers on grounds that they used the same farm tools, which in this study is different as VC factor like the use of fermentation boxes as a tool contributing among other factors in making the difference. The summative production cost estimates indicated that for certified cocoa producers to be higher per hectare per year with an average difference of FCFA 65,460. This was evidently the result of the TFC and TVC variation factors. Findings in previous studies notably Oseni and Adams (2013) in Ondo State Nigeria, Julius and Jimoh, (2020) in Ekiti State Nigeria were similar to those of this study.

TR estimates for certified producers were higher with an average difference of FCFA 91,552 ha⁻¹ y⁻¹, compared to non-certified producers. Several factors justified these results namely: productivity of certified cocoa producers was higher than that of non-certified cocoa producers due to the application of improved agricultural practices obtained from regular trainings organised by cocoa certification agents, the additional price (premium price) of FCFA 50 kg⁻¹ of cocoa sold earned by certified cocoa producers. Previous studies, such as N'Dao (2012), Ingram *et al.* (2014) in Côte d'Ivoire, N'Dri (2016) in Côte d'Ivoire and Ngoucheme *et al.* (2016) in Cameroun and Julius & Jimoh (2020) in Nigeria corroborate these findings.

GM results were positive for both producers with an average difference of FCFA 30,745 in favour of certified producers. Interestingly, the two farming types or systems (certified and non-certified) are profitable as their respective gross margins are greater than zero. This implies that certified cocoa production is more profitable than non-certified cocoa production. Given that both systems are profitable, it may be argued that the continual practice of non-certified cocoa production may be as a result of the minimal difference in the GM given that production practice is largely smallholder in nature. The NFI corroborated (with almost the same average difference FCFA 29,937 in favour of certified producers) the fact that both farm systems are profitable. These results are similar to those of Jaza *et al.* (2021) and Lescuyer & Basanaga (2021) with related evidence from Cameroon. NFI results suggests that certified cocoa producers have more opportunity to expand or intensify their farm business, replace capital, reduce debt obligations, build working capital than non-certified cocoa producers.

In both systems, NPV was positive with an average difference of FCFA 23,105 in favour of certified producer. This may be linked to the fact that higher investment potentially generates higher returns. Similar findings have previously been documented by Oseni & Adams (2013) in Ondo state

Nigeria and Samuel (2014) Upper Denkyira West District Ghana. The BCR and the IRR indicate clearly that the both farming systems are profitable though certified system was more profitable. Previous studies by AfariSefa *et al.* (2010) in Ghana, and by Oseni & Adams (2013) in Nigeria using BCR and IRR gave identical results. Interestingly, the IRR in the two systems gave 36.9 % (certified) and 35.7 % (non-certified), indicating that in the event where the producers borrowed money to ensure farm operates fulfil requirements, the producers' ability to repay the loan remained high. However, borrowing at the interest rate of 50 % ("Ten-Born-Ten") could be a very big risk to both certified and non-certified cocoa producers, though the IRR estimations within the "Ten-Born-Ten" interest principle within indicate that the certified farmer and non-certified farmer would still gain 16.9 % (36.9 %–20 %) and 15.7 % (35.7 %–20 %) of funds after reimbursement. This may be attributed to the fact that there is higher return in benefit for capital invested in certified cocoa production than non-certified cocoa production due to higher capital productivity. These results demonstrate that certified producers are making more profit than their counterpart non-certified producers.

5 Conclusion and recommendations

Innovative approaches to cocoa farming notably certification is gaining ground in the main cocoa producing countries as it seeks to improve the quality of cocoa marketed, protect the environment and improve the well-being of the producers through training and income improvement programmes (DeFries *et al.*, 2017). In spite of these advantages, non-certified cocoa production is still dominant in the study area. Findings from our empirical study in Cameroon suggest that certified cocoa farming is more profitable than non-certified cocoa farming. The study thus concludes that pushing for adoption of certified cocoa farming has a high likelihood to increase farm incomes for farmers, contribute to their socio-economic wellbeing, livelihoods as well as contribute positively to economy of Cameroon. This is likely to be more successful if experienced farmers with larger farm sizes are primarily targeted by certified cocoa production promotion schemes. The study recommends that cocoa farmers should embrace and adopt certification of cocoa farming, and that farmers should be educated by relevant stakeholders (government departments promoting agriculture, NGOs and private businesses interested in cocoa) more to embrace certification. Given that the cost related with certification may be a hindering factor, the study recommends that certification agencies should adopt means that minimise such cost so as to motivate more farmers to

join the certification process. Further, the study discourages farmers' participation the "Ten-Born-Ten" financing options that are too costly and engage more with the formal financing services that charge lower interest rates. With such, farmers will experience higher profits from their certified cocoa farming activities. As a conclusive recommendation, the study opines that the government together with certification agencies should put in place a special financial scheme for cocoa farming with lower than market interest rates to motivate interest and eventual financial returns from certified cocoa farming, with potentially positive economic and livelihoods effects.

A major shortcoming of this study is its inability to assess the social and environmental impacts of certified and non-certified cocoa production. Empirical studies of social and environmental impacts are recommended to provide a more holistic picture of the benefits of certified cocoa production. Meanwhile, systematic reviews of the profitability and environmental impacts of different cocoa production systems could provide insights relevant to policy makers in the (certified) cocoa sector.

Conflict of interest

The authors declare that they have no conflict of interest.

Supplement

The supplement related to this article is available online on the same landing page at: <https://doi.org/10.17170/kobra-2024121610772>.

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